# STATUS REPORT AND RECOMMENDATIONS
# ENVIRONMENTAL SITE ASSESSMENT

DAYTON THERMAL PRODUCTS DIVISION
DAYTON, OHIO

ACUSTAR, INC.
CHRYLSER MOTORS' CORPORATION

August 16, 1991

Prepared for:

ACUSTAR, INC.
1600 Webster Street
Dayton, Ohio 45404

Project 423023

JOHN MATHES & ASSOCIATES, INC.
East Park One Building
701 Rodi Road, Suite 101
Pittsburgh, Pennsylvania 15235-4559
(412) 824-0200

Cov/75

# BACKGROUND

- Old Maxwell Complex demolition to make space for Building 59

- Discovery of VOC and TPH contamination in areas of:

  - Concrete Slabs
  - Sewer Lines
  - Process Pipelines
  - Process Sumps
  - Nonhazardous Waste Storage Pad
  - Oil/water Separator
  - TCA Tank
  - Flux Room
  - New Product Barrel Storage
  - Battery Storage

- Soil in Footprint of Building 59

- Soil in adjacent areas to be paved

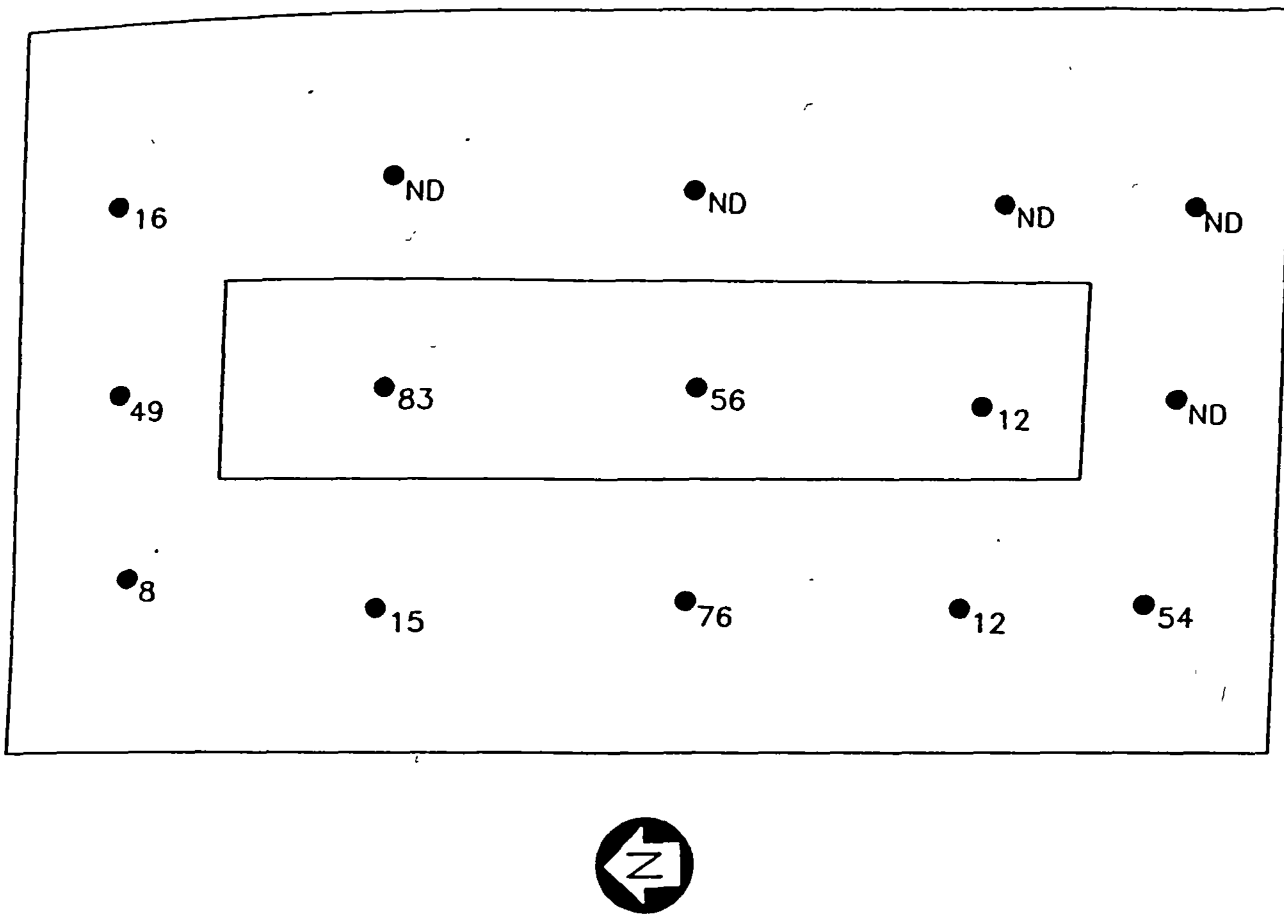
# REMEDIAL ACTIVITIES TO DATE

- Special Waste
  - Shipments to Pinnacle Road Landfill
    166 loads (~$25/cubic yard)

- Hazardous Waste
  - Soil
    F001 from 40B
    5 loads ($1,200-$1,500 per cubic yard)
  - Concrete
    Chromium leach
    Lead leach
    11 loads to date ($300-$500 per cubic yard)
    7 additional loads being evaluated

- On-Site Treatment of TPH and VOC Contaminated Soil
  - Building 59 Footprint
  - Adjacent areas to be paved

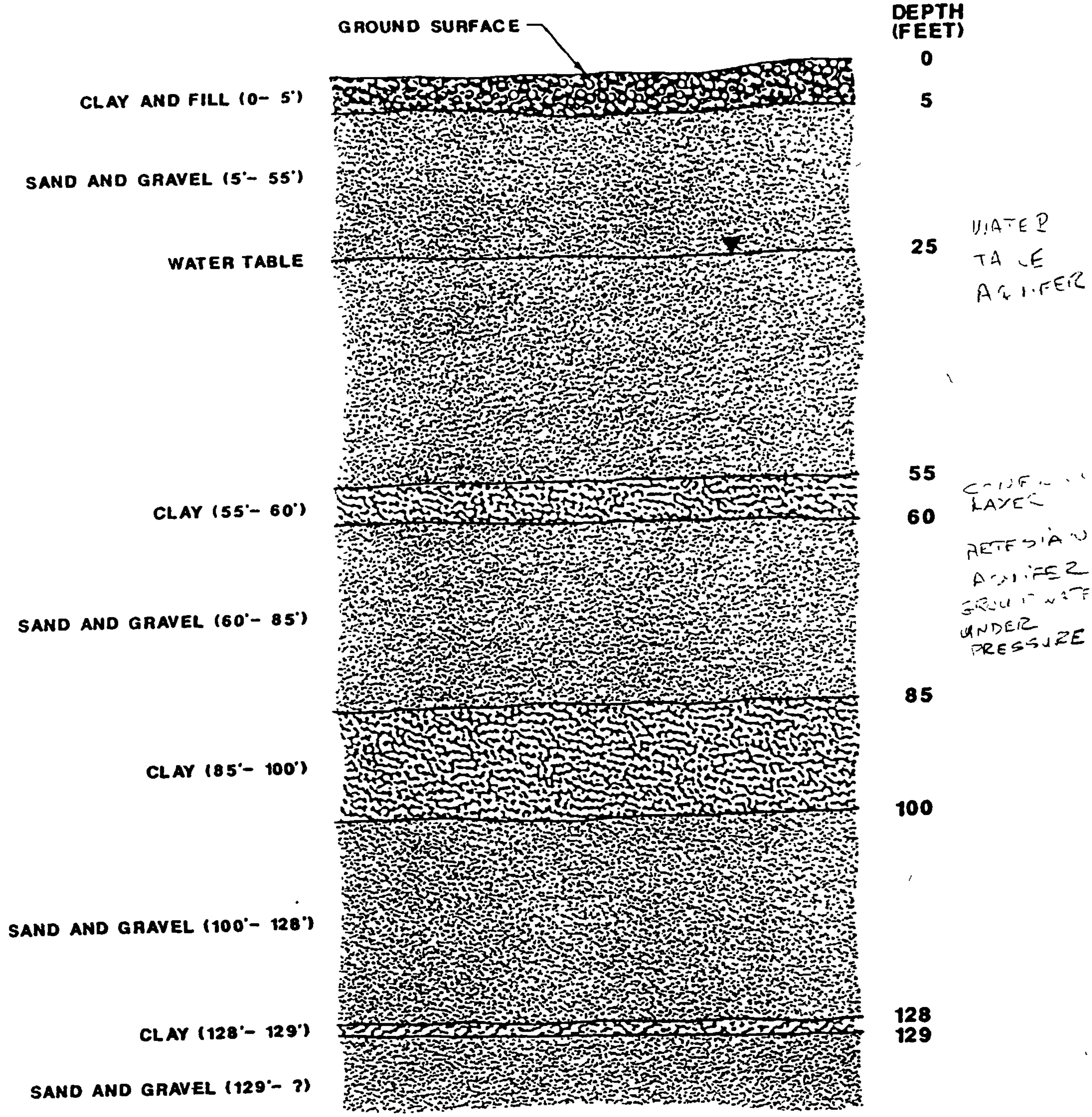
# CLEAN SOIL STOCKPILE




EXPLANATION

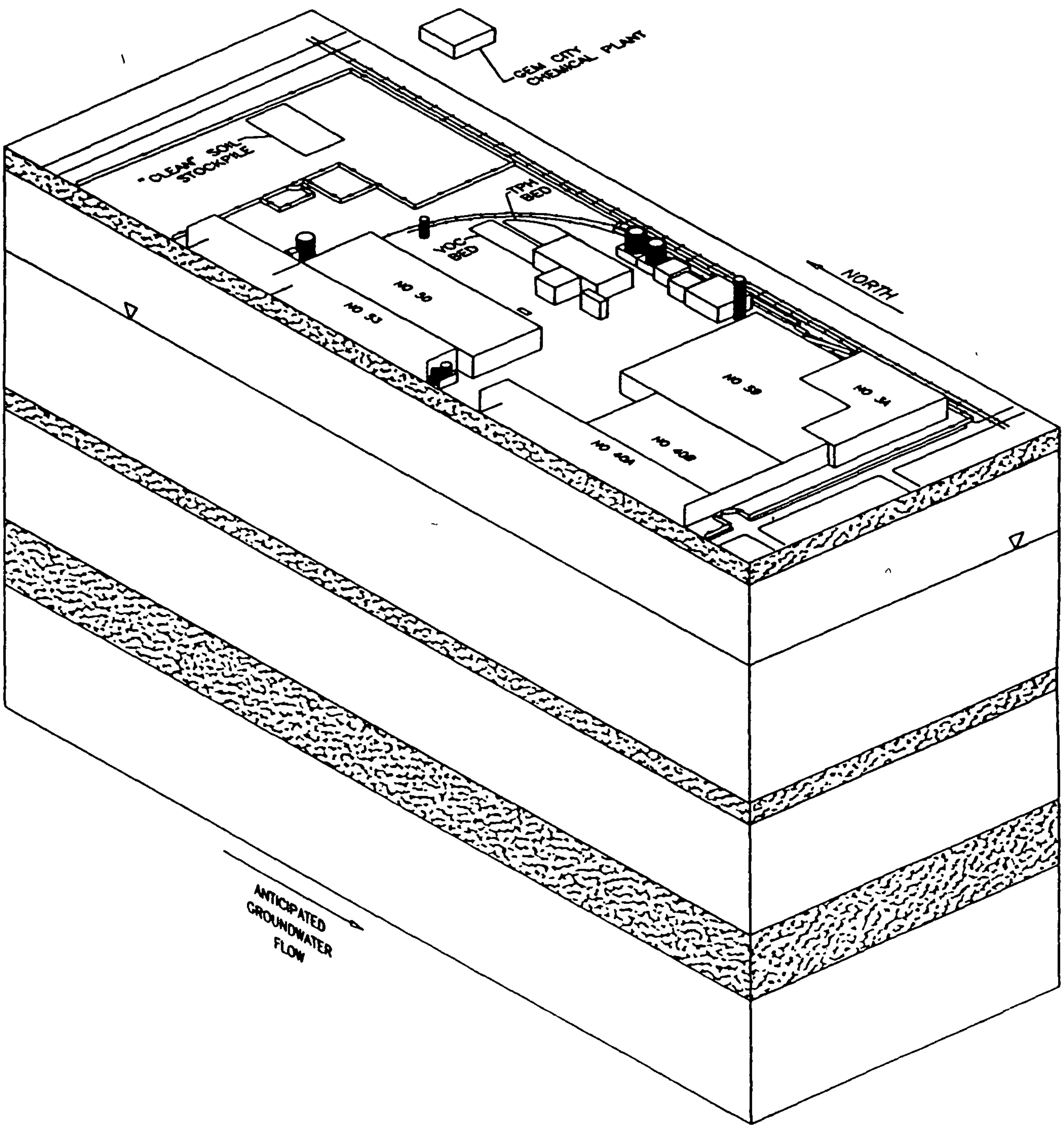
● 8 APPROXIMATE SAMPLE LOCATION WITH TOTAL VOLATILE ORGANIC COMPOUNDS (METHOD 8240) IN ug/kg

# CONCEPTUAL SUBSURFACE CONDITIONS
# DAYTON THERMAL PRODUCTS PLANT




LATERALLY CONTINUOUS

# CONCEPTUAL SUBSURFACE CONDITIONS
# DAYTON SITE



# ADDITIONAL WORK RECOMMENDED

- Prevent Identified Sources From Contaminating Aquifer — Source Control
  - 1,1,1-TCA tanks south of Building 59
  - Building 40B

- Evaluate Subsurface Conditions
  - Vertical profile and lateral extent of sediments. Delineate aquifer and semi-confining layer boundaries.
  - Aquifer, vadose zone and semi-confining layer properties:
    1. Air flow for soil venting
    2. Groundwater flow in water table and first semi-confined aquifer for groundwater remediation
    3. Semi-confining layer properties and orientation for non-aqueous phase contaminant flow

- Evaluate Risks and Options

- Select Cost-Effective Alternative(s)

## SOURCE CONTROL
## 1,1,1-TCA TANKS

OPTIONS

1. Tank System as a continuing source

   - Remove from service
   - Integrity Test
     - visual inspection
     - corrosion
     - improve material management

2. Subsurface Contamination

   - Soil

     - Excavation/removal (RCRA hazardous waste)

       Assume 100 x 100 x 25 ~ 9,000 yards
       $1,200/cubic yard for incineration

       ~$11 Million

     - Venting (minimize RCRA hazardous waste)

       ~$50,000 as part of program outlined below

   - Groundwater

     - To be selected as part of site-wide evaluation

# SOURCE CONTROL
# BUILDING 40B

## OPTIONS

1. Building as a Continuing Source

- Remove from service
  - improve material management practices
  - discontinue use of solvents
  - halt production

- Isolate from environment
  - venting system discussed below

2. Subsurface Contamination

- Soil
  - 127,000 cubic yards may be affected
  - All subsurface work will generate RCRA hazardous waste (requires handling at $1,200-1,500/cubic yard)
  - Excavation/Removal
    All RCRA hazardous waste - $152 million
  - Venting
    Minimize generation of RCRA hazardous waste - $0.7-$1.5 million

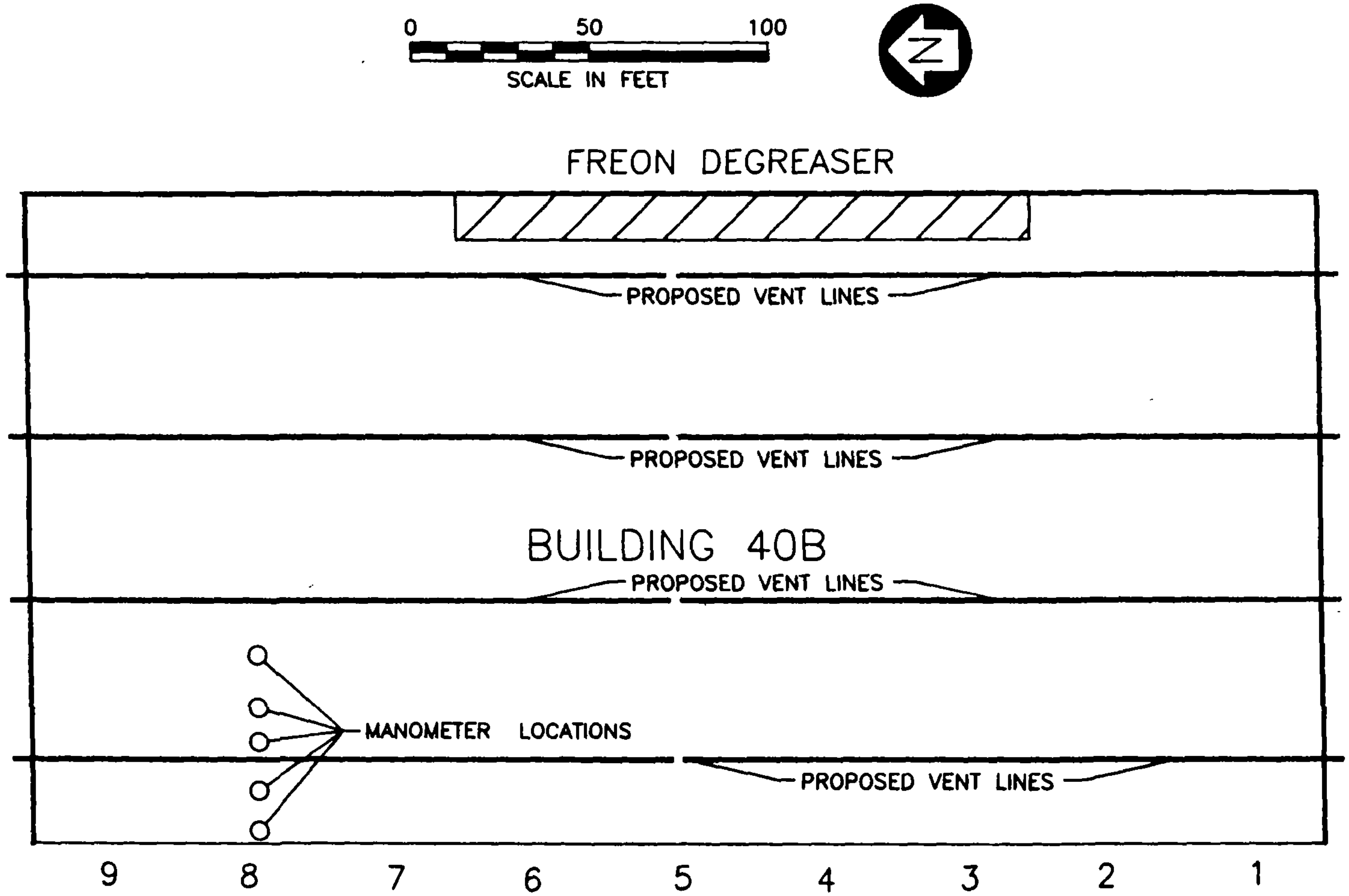
    a. Vertical - not most cost-effective option due to site logistics

    b. Horizontal
       - from surface - infeasible logistically
       - from outside of building

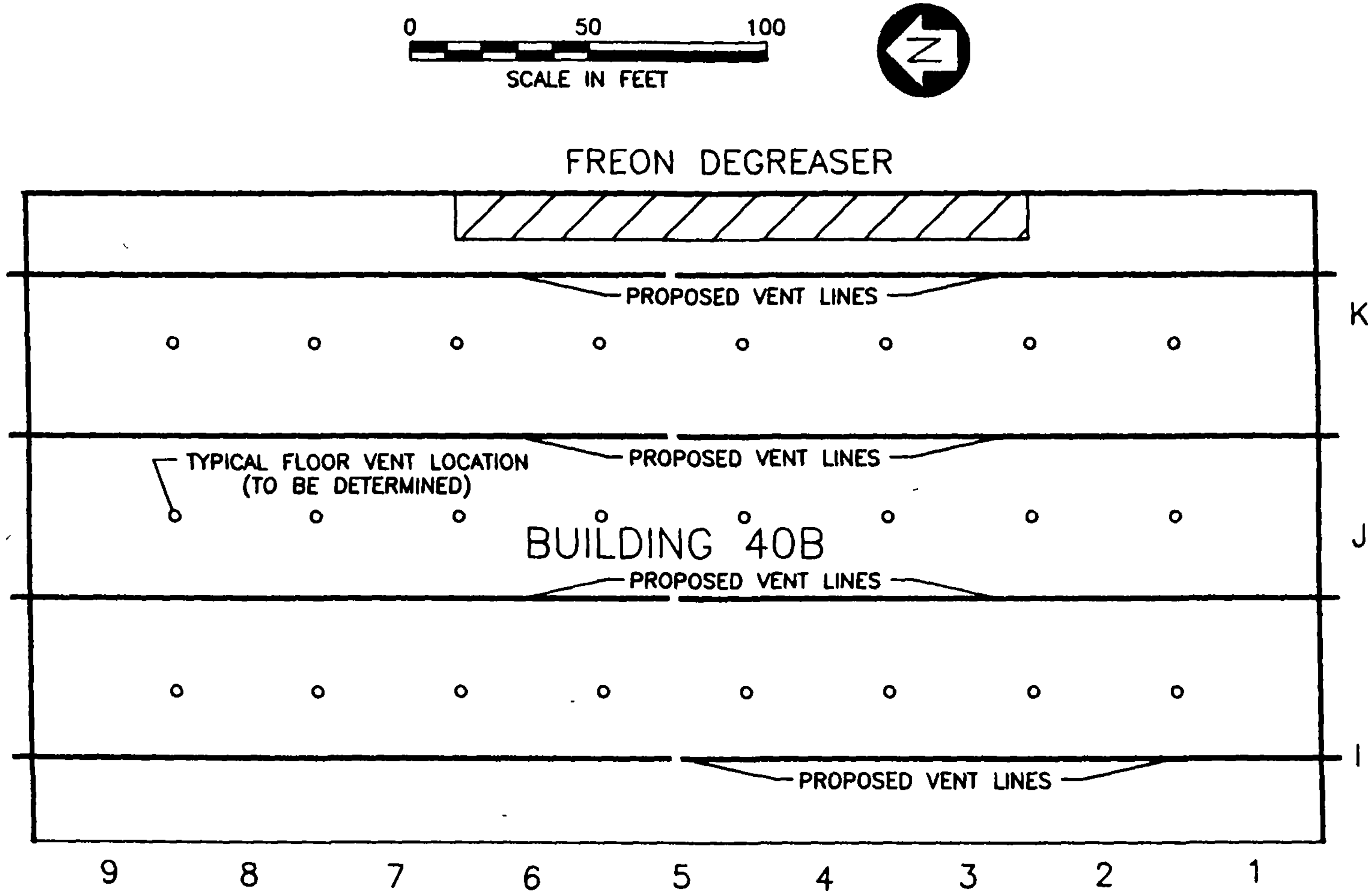
    Program outlined below

- Groundwater
  - To be selected as part of site-wide evaluation

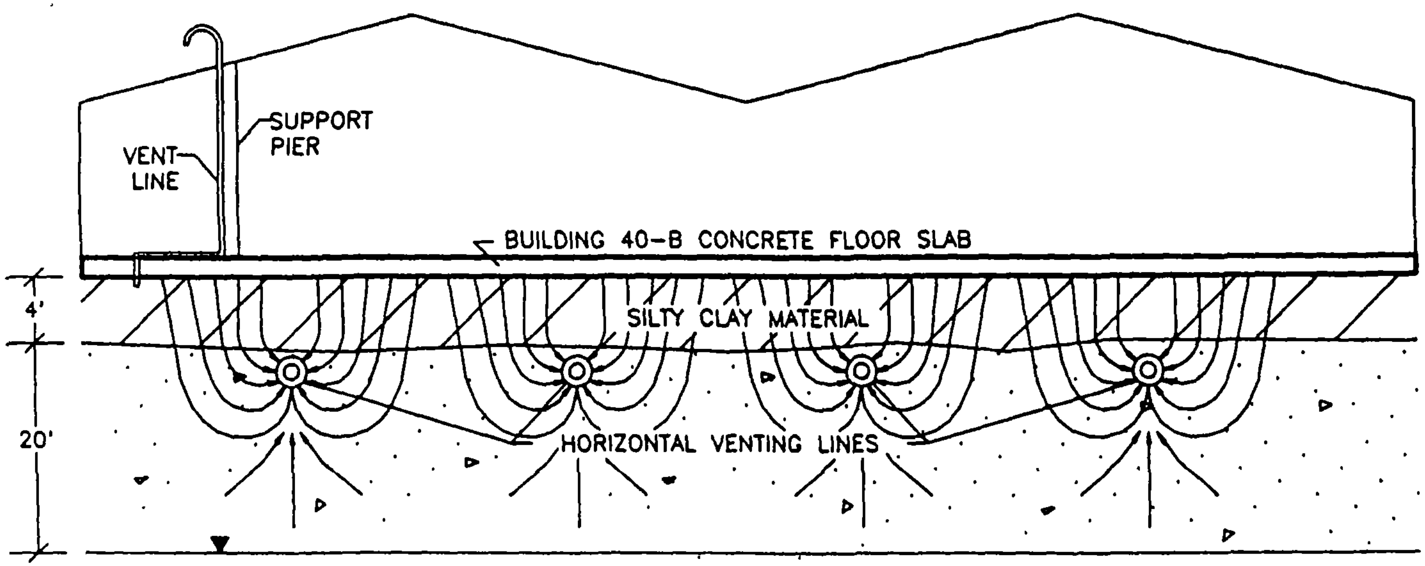
# PROPOSED LOCATION FOR HORIZONTAL VENTING LINES HORIZONTAL SOIL VENTING SYSTEM



# TYPICAL FLOOR VENTING LOCATION
# HORIZONTAL SOIL VENTING SYSTEM



# CROSS SECTION DIAGRAM OF PROPOSED VENTING SYSTEM




NOT TO SCALE

# SUBSURFACE ASSESSMENT AND CLEANUP EVALUATION ANTICIPATED SCOPE OF WORK

- Evaluate subsurface soil condition in area of 1,1,1-TCA tanks and storage area east of Building 50
  - VOCs
  - Grain size distribution
  - Response testing (venting test)
    - to evaluate, design, and cost soil venting as a remedial alternative

- Advance deep (100 feet) boreholes to evaluate continuity of stratigraphy
  - Six boreholes through base of "confined" saturated zone
  - Evaluate data requirements
  - Install wells

- Advance shallow (55 feet) boreholes to evaluate water table and continuity of confining zone
  - Six boreholes to base of first "confining" layer
  - Evaluate data requirements
  - Install wells

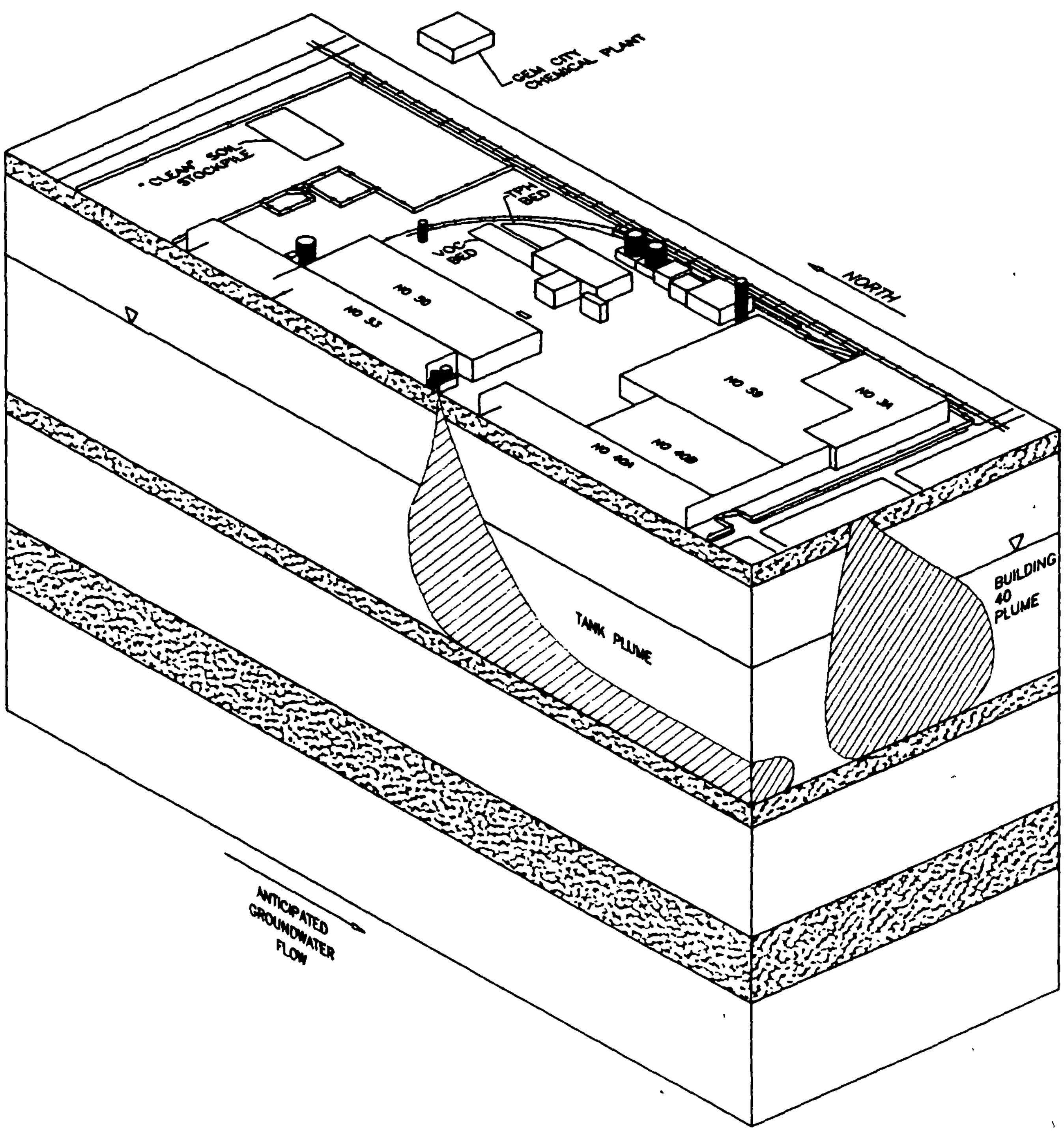
- Evaluate groundwater and properties of water table and first "confined" zone
  - Flow direction
  - Water quality (VOCs plus parameters required for remediation)
  - Response testing (pumping test)
    - to select and design appropriate remedial method

- Evaluate cleanup standards
  - ARARs
  - RCRA Corrective Action Levels
  - Health-risk based levels

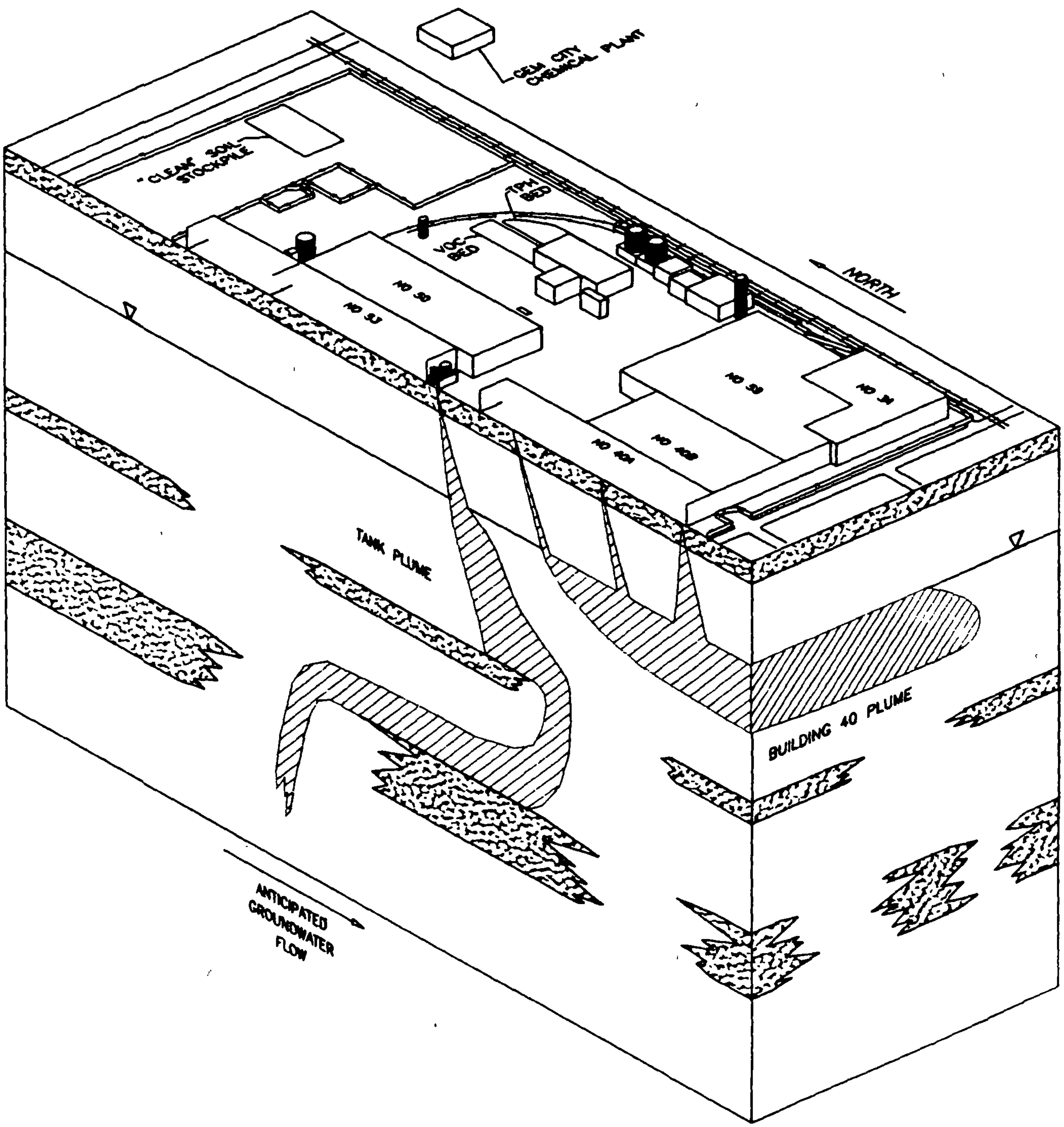
- Engineering evaluation
  - Soil
  - Groundwater

- Recommendations

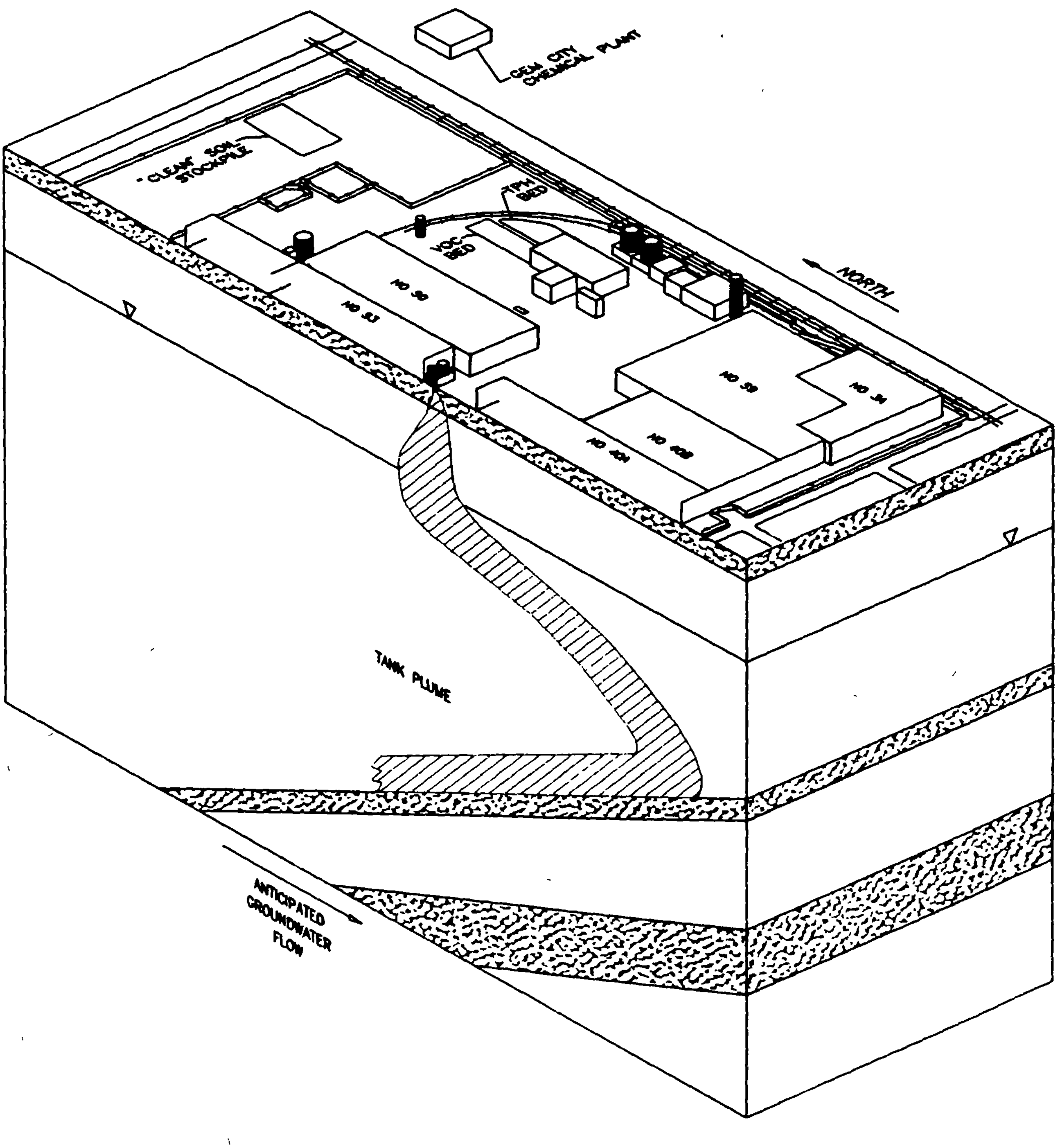
# CONCEPTUAL SUBSURFACE CONDITIONS
# DAYTON SITE
# "HORIZONTAL" CONFINING LAYER



# CONCEPTUAL SUBSURFACE CONDITIONS
# DAYTON SITE
# "LEAKY" CONFINING LAYER



# CONCEPTUAL SUBSURFACE CONDITIONS
# DAYTON SITE
# "TILTING" CONFINED LAYER



# DRIVING FORCES/CONCERNS

- Release of hazardous substance/waste to the environment

- Affects groundwater above federally promulgated maximum contaminant levels (MCLs) (drinking water)

- Previously pumped contaminated Power House well for 90 days @ 1 million gallons per day - no change in contaminant level (large volume affected)

- Potential for off-site migration
  - increases difficulty ($) of recovery

- Minimize potential Superfund "PRP" responsibility/ participation of Dayton aquifer remediation

- Evaluate "Island of Purity" concept
  - remediate media affected by plant

Table 1

RECON[SM] SAMPLE ANALYSIS SUMMARY
DATA SUMMARY TABLE

DAYTON THERMAL PRODUCTS DIVISION
ACUSTAR, INC.
DAYTON, OHIO

| Sample I.D. | Probe Hole Number | Depth (Feet) | 1,1-DCE (ug/L) | trans-1,2-DCE (ug/L) | cis-1,2-DCE (ug/L) | 1,1,1-TCA (ug/L) | TCE (ug/L) | PERC (ug/L) | Comments |
|---|---|---|---|---|---|---|---|---|---|
| Blank-01 | --- | --- | ND(1) | ND(1) | ND(1) | ND(1) | ND(2) | ND(2) | QC System Blank |
| Blank-02 | --- | --- | ND(1) | ND(1) | ND(1) | ND(1) | ND(2) | ND(2) | QC Rod Blank |
| DSG-01 | PH-01 | 3-4 | ND(1) | ND(1) | ND(1) | ND(1) | ND(2) | ND(2) | Soil Gas |
| DSG-02 | PH-01 | 7.5-8.5 | 10 | ND(1) | 41 | 168 | 130 | 33 | Soil Gas |
| DSG-03 | PH-01 | 13.5-14.5 | 41 | 35 | 20 | 1013 | 176 | 26 | Soil Gas |
| DSG-04 | PH-01 | 19-20 | 132 | ND(1) | 21 | 3210 | 388 | 38 | Soil Gas |
| DSG-05 | PH-01 | 24-25 | 8 | ND(1) | 24 | 255 | 66 | 40 | Soil Gas |
| DGW-06 | PH-01 | 28-30 | 1103 | ND(1) | 106 | 916 | 52 | ND(2) | Groundwater Headspace (D) |
| DSG-07 | PH-02 | 3-4 | ND(1) | ND(1) | ND(1) | ND(1) | ND(2) | ND(2) | Soil Gas |
| DSG-08 | PH-02 | 7.5-8.5 | 6 | ND(1) | ND(1) | 8 | 15 | ND(2) | Soil Gas |
| DSG-09 | PH-02 | 13.5-14.5 | 284 | ND(1) | ND(1) | 134 | 204 | 33 | Soil Gas |
| Blank-03 | --- | --- | ND(1) | ND(1) | ND(1) | ND(1) | ND(2) | ND(2) | QC System Blank |
| DSG-10 | PH-02 | 19-20 | 2324 | ND(1) | 10 | 268 | 385 | 56 | Soil Gas |
| DSG-10D | PH-02 | 19-20 | 2315 | ND(1) | 10 | 267 | 382 | 54 | QC Duplicate (SG) |
| DSG-11 | PH-02 | 24-25 | 17 | ND(1) | ND(1) | ND(1) | 11 | ND(2) | Soil Gas |
| Blank-04 | --- | --- | ND(1) | ND(1) | ND(1) | ND(2) | ND(2) | ND(2) | QC System Blank |
| Blank-05 | --- | -- | ND(1) | ND(1) | ND(1) | ND(2) | ND(2) | ND(2) | QC Rod Blank |
| DGW-12 | PH-02 | 29.5 | 115 | 13 | 1035 | 844 | 3226 | ND(2) | Groundwater Headspace |
| DGW-12D | PH-02 | 29.5 | 122 | 16 | 1057 | 847 | 3343 | ND(2) | QC Duplicate (GWHS) |
| DSG-13 | PH-03 | 7.5-8.5 | 62 | ND(1) | ND(1) | 58 | 54 | ND(2) | Soil Gas |
| DSG-14 | PH-03 | 19-20 | ND(1) | ND(1) | ND(1) | ND(2) | ND(2) | ND(2) | Soil Gas |
| DGW-15 | PH-03 | 24-25 | 2665 | ND(1) | 305 | 3128 | 9150 | ND(2) | Groundwater Headspace |
| DSG-16 | PH-04 | 13.5-14.5 | 89 | ND(1) | ND(1) | 91 | 122 | 16 | Soil Gas |
| DSG-17 | PH-04 | 19-20 | 236 | ND(1) | 7 | 337 | 333 | 33 | Soil Gas |
| DGW-18 | PH-04 | 24-25 | 1405 | ND(1) | 189 | 4131 | 5652 | ND(2) | Groundwater Headspace |
| Blank-06 | --- | --- | ND(1) | ND(1) | ND(1) | ND(2) | ND(2) | ND(2) | QC Blank |
| DGW-19 | PH-04 | 29.5-30.5 | 782 | ND(1) | 215 | 3173 | 5128 | ND(2) | Groundwater Headspace (D) |
| DSG-20 | PH-05 | 7.5-8.5 | ND(1) | ND(1) | ND(1) | ND(2) | 15 | ND(2) | Soil Gas |
| DSG-21 | PH-05 | 19-20 | ND(1) | ND(1) | ND(1) | 7 | 29 | ND(2) | Soil Gas |
| DGW-22 | PH-05 | 24-25 | ND(1) | ND(1) | ND(1) | 14 | 87 | ND(2) | Groundwater Headspace |
| Blank-07 | --- | --- | ND(1) | ND(1) | ND(1) | ND(2) | ND(2) | ND(2) | QC System Blank |

Table 1 (Continued)

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|---|---|---|---|---|---|---|---|---|---|
| Blank-08A | --- | --- | ND(1) | ND(1) | ND(1) | ND(2) | ND(2) | ND(2) | QC Rod Blank |
| DSG-23 | PH-06 | 7.5-8.5 | 50 | ND(1) | 5 | 171 | 370 | ND(2) | Soil Gas |
| DSG-24 | PH-06 | 19-20 | 814 | ND(1) | 28 | 1191 | 1687 | 12 | Soil Gas |
| DGW-25 | PH-06 | 24-25 | 225 | ND(1) | 27 | 651 | 816 | ND(2) | Groundwater Headspace |
| DSG-26 | Bay I-4A | 1-2 | 144 | 14 | 209 | ND(2) | 714 | 186 | Soil Gas |
| DSG-27 | Bay I-4A | 3-4 | 635 | ND(1) | 166 | 15 | ND(2) | 861 | Soil Gas |
| DSG-28 | Bay I-4A | 6-7 | 1016 | ND(1) | 189 | 20 | 445 | 637 | Soil Gas |
| DSG-29 | Bay I-3A | 1-2 | 15 | ND(1) | 219 | ND(2) | 84 | 15 | Soil Gas |
| DSG-30 | Bay K-2 | 1-2 | 110 | ND(1) | 76 | 52 | 627 | ND(2) | Soil Gas |
| DSG-31 | Bay I-3A | 3-4 | 16 | ND(1) | 179 | ND(2) | 364 | 347 | Soil Gas |
| Blank-08B | --- | --- | ND(1) | ND(1) | ND(1) | ND(2) | ND(2) | ND(2) | QC System Blank |
| DSG-32 | Bay K-2 | 3-4 | 10 | ND(1) | ND(1) | ND(2) | ND(2) | ND(2) | Soil Gas |
| DSG-32D | Bay K-2 | 3-4 | 10 | ND(1) | ND(1) | ND(2) | ND(2) | ND(2) | QC Duplicate (SG) |
| DSG-33 | Bay K-2 | 6-7 | 126 | ND(1) | 214 | 100 | 968 | ND(2) | Soil Gas |
| DSG-34 | Bay I-3A | 6-7 | 15 | ND(1) | 175 | ND(2) | 351 | 316 | Soil Gas |
| DSG-34D | Bay I-3A | 6-7 | 17 | ND(1) | 169 | ND(2) | 341 | 307 | QC Duplicate (SG) |
| DSG-35 | Bay I-3B | 1-2 | 164 | 6 | 155 | ND(2) | 258 | 249 | Soil Gas |
| DSG-36 | Bay I-3B | 3-4 | 154 | ND(1) | 163 | ND(2) | 301 | 243 | Soil Gas |
| DSG-37 | Bay I-3B | 6-7 | 208 | ND(1) | 213 | 7 | 393 | 252 | Soil Gas |
| Blank-09 | --- | --- | ND(1) | ND(1) | ND(1) | ND(2) | ND(2) | ND(2) | QC System Blank |
| Blank-10 | --- | --- | ND(1) | ND(1) | ND(1) | ND(2) | ND(2) | ND(2) | QC System Blank |
| Blank-11 | --- | --- | ND(1) | ND(1) | ND(1) | ND(2) | ND(2) | ND(2) | QC Rod Blank |
| DSG-38 | PL-24 | 7.5-8.5 | ND(1) | ND(1) | ND(1) | ND(2) | ND(2) | ND(2) | Soil Gas |
| DSG-39 | PL-24 | 19-20 | ND(1) | ND(1) | ND(1) | ND(2) | ND(2) | ND(2) | Soil Gas |
| DGW-40 | PL-24 | 20-24 | ND(1) | ND(1) | ND(1) | ND(2) | ND(2) | ND(2) | Groundwater Headspace |
| DGW-40D | PL-24 | 20-24 | ND(1) | ND(1) | ND(1) | ND(2) | ND(2) | ND(2) | QC Duplicate (GWHS) |
| DSG-41 | Bay K-3 | 0-1 | 812 | ND(1) | 47 | 73 | 290 | ND(2) | Soil Gas |
| DSG-42 | Bay K-3 | 3-4 | 1076 | ND(1) | 105 | 167 | 528 | ND(2) | Soil Gas |
| DSG-43 | Bay K-3 | 6-7 | 1455 | ND(1) | 145 | 277 | 714 | 20 | Soil Gas |
| DSG-44 | PH-07 | 7.5-8.5 | 38 | ND(1) | 996 | ND(1) | 415 | 146 | Soil Gas |
| DSG-45 | PH-07 | 19-20 | 13 | ND(1) | 193 | 42 | 231 | 319 | Soil Gas |

Table 1 (Continued)

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| Sample I.D. | Probe Hole Number | Depth (Feet) | 1,1-DCE (ug/L) | trans-1,2-DCE (ug/L) | cis-1,2-DCE (ug/L) | 1,1,1-TCA (ug/L) | TCE (ug/L) | PERC (ug/L) | Comments |
|---|---|---|---|---|---|---|---|---|---|
| DGW-46 | PH-07 | 24-25 | ND(1) | ND(1) | 130 | 21 | 86 | 101 | Groundwater Headspace |
| DSG-47 | Bay K-4 | 0-1 | 6154 | ND(1) | 132 | 396 | 714 | ND(2) | Soil Gas |
| DSG-48 | Bay K-4 | 3-4 | 4683 | ND(1) | 67 | 381 | 631 | 21 | Soil Gas |
| DSG-49 | Bay K-4 | 6-7 | 7185 | ND(1) | 46 | 379 | 409 | 48 | Soil Gas |
| Blank-12 | --- | --- | ND(1) | ND(1) | ND(1) | ND(2) | ND(2) | ND(2) | QC System Blank |
| Blank-13 | --- | --- | ND(1) | ND(1) | ND(1) | ND(2) | ND(2) | ND(2) | QC System Blank |
| Blank-14 | --- | --- | ND(1) | ND(1) | ND(1) | ND(2) | ND(2) | ND(2) | QC Ambient Blank |
| DSG-50 | Bay K-5 | 0-1 | 258636 | ND(1) | 139 | 950 | 1516 | 14 | Soil Gas |
| DSG-51 | Bay K-5 | 3-4 | 153188 | ND(1) | 159 | 1792 | 3172 | 45 | Soil Gas |
| DSG-52 | Bay K-5 | 6-7 | 42530 | ND(1) | 45 | 574 | 733 | 35 | Soil Gas |
| DSG-53 | Bay G-1 | 0-1 | 23 | ND(1) | ND(1) | ND(2) | 52 | 150 | Soil Gas |
| DSG-54 | Bay G-1 | 3-4 | 11 | ND(1) | 4 | 11 | 130 | 451 | Soil Gas |
| DSG-55 | Bay G-1 | 6-7 | 5 | ND(1) | 5 | 6 | 94 | 378 | Soil Gas |
| Blank-15 | --- | --- | ND(1) | ND(1) | ND(1) | ND(2) | ND(2) | ND(2) | QC System Blank |
| DSG-56 | Bay K-6 | 0-1 | 3367 | ND(1) | 15 | 101 | 221 | 28 | Soil Gas |
| DSG-57 | Bay K-6 | 3-4 | 3210 | ND(1) | 5 | 68 | 166 | 12 | Soil Gas |
| DSG-58 | Bay K-6 | 6-7 | 3681 | ND(1) | 8 | 140 | 295 | 22 | Soil Gas |
| DSG-59 | Bay K-7 | 0-1 | 485 | ND(1) | 32 | 136 | 271 | 48 | Soil Gas |
| DSG-60 | Bay K-7 | 3-4 | 1251 | ND(1) | 30 | 452 | 643 | 54 | Soil Gas |
| DSG-61 | Bay K-7 | 6-7 | 1291 | ND(1) | 19 | 525 | 696 | 52 | Soil Gas |
| DSG-62 | Bay G-3 | 0-1 | 5 | ND(1) | ND(1) | ND(2) | 12 | 37 | Soil Gas |
| DSG-63 | Bay G-3 | 3-4 | 24 | ND(1) | 5 | ND(2) | 55 | 176 | Soil Gas |
| DSG-63D | Bay G-3 | 3-4 | 26 | ND(1) | 5 | ND(2) | 59 | 171 | QC Duplicate (SG) |
| DSG-64 | Bay G-3 | 6-7 | 41 | ND(1) | ND(1) | ND(2) | 32 | 113 | Soil Gas |
| DSG-65 | Bay K-8 | 0-1 | 714 | ND(1) | 153 | 1238 | 1202 | 38 | Soil Gas |
| DSG-66 | Bay K-8 | 3-4 | 457 | ND(1) | 36 | 496 | 665 | 35 | Soil Gas |
| DSG-67 | Bay K-8 | 6-7 | 545 | ND(1) | 19 | 652 | 630 | 35 | Soil Gas |
| DSG-68 | Bay G-4 | 0-1 | 73 | ND(1) | 13 | 8 | 68 | 354 | Soil Gas |
| DSG-69 | Bay G-4 | 3-4 | 34 | ND(1) | ND(1) | ND(2) | 12 | 46 | Soil Gas |
| DSG-70 | Bay G-4 | 6-7 | 135 | ND(1) | ND(1) | ND(2) | ND(2) | ND(2) | Soil Gas |
| Blank-16 | --- | --- | ND(1) | ND(1) | ND(1) | ND(2) | ND(2) | ND(2) | QC System Blank |

Table 1 (Continued)

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|---|---|---|---|---|---|---|---|---|---|
| DSG-71 | Bay K-9 | 0-1 | 176 | ND(1) | 27 | 70 | 156 | ND(2) | Soil Gas |
| DSG-72 | Bay K-9 | 3-4 | 60 | ND(1) | 47 | 63 | 54 | 14 | Soil Gas |
| DSG-73 | Bay K-9 | 6-7 | 146 | ND(1) | 285 | 481 | 268 | 48 | Soil Gas |
| Blank-17 | --- | --- | ND(1) | ND(1) | ND(1) | ND(2) | ND(2) | ND(2) | QC System Blank |
| Blank-18 | --- | --- | 6 | ND(1) | ND(1) | 13 | 27 | ND(2) | QC Rod Blank |
| Blank-18D | --- | --- | 6 | ND(1) | ND(1) | ND(2) | ND(2) | ND(2) | QC Rod Blank |
| DSG-74 | Bay G-5 | 0-1 | 52 | ND(1) | ND(1) | ND(2) | 10 | 54 | Soil Gas |
| DSG-75 | Bay G-5 | 3-4 | 154 | ND(1) | 4 | ND(2) | 16 | 72 | Soil Gas |
| DSG-76 | Bay G-5 | 6-7 | 210 | ND(1) | 5 | ND(2) | 10 | 52 | Soil Gas |
| DSG-77 | Bay G-6 | 3-4 | 127 | ND(1) | ND(1) | ND(2) | 8 | 37 | Soil Gas |
| DSG-78 | Bay G-6 | 0-1 | 20 | ND(1) | ND(1) | ND(2) | 9 | 41 | Soil Gas |
| DSG-79 | Bay G-6 | 6-7 | 333 | ND(1) | 5 | ND(2) | 10 | 34 | Soil Gas |
| DSG-80 | Bay J-2 | 0-1 | ND(1) | ND(1) | ND(1) | ND(2) | 25 | ND(2) | Soil Gas |
| DSG-81 | Bay J-2 | 3-4 | 4 | ND(1) | 6 | ND(2) | 11 | ND(2) | Soil Gas |
| DSG-82 | Bay J-2 | 5-7 | 14 | ND(1) | 17 | ND(2) | 21 | ND(2) | Soil Gas |
| Blank-19 | --- | --- | ND(1) | ND(1) | ND(2) | ND(2) | ND(2) | ND(2) | QC System Blank |
| DSG-83 | Bay J-9 | 0-1 | ND(1) | ND(1) | ND(2) | ND(2) | ND(2) | ND(2) | Soil Gas |
| DSG-84 | Bay J-9 | 3-4 | 8 | ND(1) | ND(1) | ND(2) | ND(2) | ND(2) | Soil Gas |
| DSG-85 | Bay J-9 | 6-7 | ND(1) | ND(1) | ND(1) | ND(2) | ND(2) | ND(2) | Soil Gas |
| DSG-86 | Bay G-8 | 0-1 | 33 | ND(1) | 7 | 12 | 19 | 62 | Soil Gas |
| DSG-86D | Bay G-8 | 0-1 | 33 | ND(1) | 7 | 14 | 21 | 61 | QC Duplicate (SG) |
| DSG-87 | Bay G-8 | 3-4 | 1431 | ND(1) | 120 | 233 | 261 | 1104 | Soil Gas |
| DSG-88 | Bay G-8 | 6-7 | 578 | ND(1) | 67 | 134 | 162 | 571 | Soil Gas |
| DSG-89 | Bay I-9 | 0-1 | 3 | ND(1) | ND(1) | ND(2) | 8 | ND(2) | Soil Gas |
| DSG-90 | Bay I-9 | 3-4 | 9 | ND(1) | ND(1) | 6 | 50 | ND(2) | Soil Gas |
| DSG-91 | Bay I-9 | 6-7 | 230 | ND(1) | 6 | 9 | 261 | 22 | Soil Gas |
| Blank-20 | --- | --- | ND(1) | ND(1) | ND(1) | ND(2) | ND(2) | ND(2) | QC System Blank |
| DSG-92 | Bay G-9 | 0-1 | 9 | ND(1) | ND(1) | 26 | 19 | 12 | Soil Gas |
| DSG-93 | Bay G-9 | 3-4 | 4 | ND(1) | ND(1) | 10 | 15 | 17 | Soil Gas |
| DSG-94 | Bay G-9 | 6-7 | 291 | ND(1) | 7 | 33 | 25 | 108 | Soil Gas |
| DSG-95 | Bay H-13 | 0-1 | 76 | ND(1) | 6 | 1164 | 48 | 187 | Soil Gas |
| DSG-95D | Bay H-13 | 0-1 | 75 | ND(1) | 6 | 1782 | 49 | 190 | QC Duplicate (SG) |

Table 1 (Continued)

RECON[SM] SAMPLE ANALYSIS SUMMARY
DATA SUMMARY TABLE

DAYTON THERMAL PRODUCTS DIVISION
ACUSTAR, INC.
DAYTON, OHIO

| Sample I.D. | Probe Hole Number | Depth (Feet) | 1,1-DCE (ug/L) | trans-1,2-DCE (ug/L) | cis-1,2-DCE (ug/L) | 1,1,1-TCA (ug/L) | TCE (ug/L) | PERC (ug/L) | Comments |
|---|---|---|---|---|---|---|---|---|---|
| DSG-96 | Bay H-13 | 3-4 | 11 | 14 | ND(2) | 83 | ND(2) | 11 | Soil Gas |
| DSG-97 | Bay H-13 | 6-7 | 34 | ND(1) | ND(2) | 698 | 38 | 59 | Soil Gas |
| Blank-21 | --- | --- | ND(1) | ND(1) | ND(1) | ND(2) | ND(2) | ND(2) | QC System Blank |
| Blank-22 | --- | --- | ND(1) | ND(1) | ND(1) | 6 | ND(2) | ND(2) | QC Rod Blank |
| DSG-98 | Bay G-10 | 0-1 | 6 | ND(1) | ND(1) | 11 | 24 | ND(2) | Soil Gas |
| DSG-99 | Bay G-10 | 3-4 | ND(1) | ND(1) | ND(1) | ND(2) | ND(2) | ND(2) | Soil Gas |
| DSG-100 | Bay G-10 | 6-7 | 49 | ND(1) | ND(1) | 30 | ND(2) | 9 | Soil Gas |
| DSG-101 | Bay K-1 | 0-1 | ND(1) | ND(1) | 11 | 8 | 83 | ND(2) | Soil Gas |
| DSG-102 | Bay K-1 | 3-4 | ND(1) | ND(1) | 64 | 10 | 206 | ND(2) | Soil Gas |
| DSG-103 | Bay K-1 | 6-7 | 6 | ND(1) | 145 | 13 | 323 | ND(2) | Soil Gas |
| AMB | --- | --- | 308 | ND(1) | ND(1) | ND(2) | ND(2) | ND(2) | Ambient Inside Building* |
| DSG-104 | Bay G-12 | 0-1 | 93 | ND(1) | ND(1) | 367 | 12 | 10 | Soil Gas |
| DSG-105 | Bay G-12 | 3-4 | 152 | ND(2) | ND(2) | 1993 | 15 | ND(2) | Soil Gas |
| DSG-106 | Bay G-12 | 6-7 | 2108 | ND(2) | 13 | 2536 | 63 | 270 | Soil Gas |
| DSG-106D | Bay G-12 | 6-7 | 2118 | ND(2) | 13 | 2538 | 63 | 266 | QC Duplicate (SG) |
| Blank-23 | --- | --- | ND(1) | ND(1) | ND(1) | ND(2) | ND(2) | ND(2) | QC System Blank |
| DSG-107 | Bay H-12B | 0-1 | 3794 | ND(1) | ND(1) | 2968 | 34 | 157 | Soil Gas |
| DSG-108 | Bay H-12B | 3-4 | ND(1) | ND(1) | ND(1) | 3380 | 31 | 93 | Soil Gas |
| DSG-109 | Bay H-12B | 6-7 | 7388 | ND(1) | ND(1) | 3630 | 30 | 81 | Soil Gas |
| DSG-110 | Bay G-11 | 0-1 | ND(1) | ND(1) | ND(1) | 123 | 71 | ND(2) | Soil Gas |
| DSG-111 | Bay G-11 | 3-4 | 11 | ND(1) | ND(1) | 48 | 23 | ND(2) | Soil Gas |
| DSG-112 | Bay G-11 | 6-7 | 122 | ND(1) | ND(1) | 65 | ND(2) | 10 | Soil Gas |
| DSG-113 | Bay H-1 | 0-1 | 5 | ND(1) | 4 | 30 | 277 | 232 | Soil Gas |
| DSG-114 | Bay H-1 | 3-4 | ND(1) | ND(1) | ND(1) | ND(2) | ND(2) | ND(2) | Soil Gas |
| DSG-115 | Bay H-1 | 6-7 | ND(1) | ND(1) | 6 | 15 | 30 | 82 | Soil Gas |
| Blank-24A | --- | --- | ND(1) | ND(1) | ND(1) | ND(2) | ND(2) | ND(2) | QC System Blank |
| Blank-24B | --- | --- | ND(1) | ND(1) | ND(1) | ND(2) | ND(2) | ND(2) | QC System Blank |
| Blank-25 | --- | --- | 15 | ND(1) | ND(1) | ND(2) | ND(2) | ND(2) | QC Rod Blank |
| DSG-116 | Bay I-1 | 0-1 | 5 | ND(1) | 32 | 7 | 126 | 15 | Soil Gas |
| DSG-117 | Bay I-1 | 3-4 | ND(1) | ND(1) | 82 | ND(2) | 190 | 13 | Soil Gas |
| DSG-118 | Bay I-1 | 6-7 | ND(1) | ND(1) | 82 | ND(2) | 166 | ND(2) | Soil Gas |

Table 1 (Continued)

RECON[SM] SAMPLE ANALYSIS SUMMARY
DATA SUMMARY TABLE

DAYTON THERMAL PRODUCTS DIVISION
ACUSTAR, INC.
DAYTON, OHIO

| Sample I.D. | Probe Hole Number | Depth (Feet) | 1,1-DCE (ug/L) | trans-1,2-DCE (ug/L) | cis-1,2-DCE (ug/L) | 1,1,1-TCA (ug/L) | TCE (ug/L) | PERC (ug/L) | Comments |
|---|---|---|---|---|---|---|---|---|---|
| DSG-119 | Bay H-11 | 0-1 | 16 | ND(1) | 5 | 767 | 23 | 38 | Soil Gas |
| DSG-120 | Bay H-11 | 3-4 | 11 | ND(1) | ND(1) | 413 | 31 | 19 | Soil Gas |
| DSG-121 | Bay H-11 | 6-7 | 12 | ND(1) | 4 | 295 | 104 | 19 | Soil Gas |
| DSG-122 | NE-24 | 9-10 | ND(1) | ND(1) | ND(1) | ND(2) | ND(2) | ND(2) | Soil Gas |
| DSG-123 | NE-24 | 19-20 | ND(1) | ND(1) | ND(1) | 14 | 8 | 116 | Soil Gas |
| Blank-26 | --- | --- | ND(1) | ND(1) | ND(1) | ND(2) | ND(2) | ND(2) | QC System Blank |
| Blank-27 | --- | --- | ND(1) | ND(1) | ND(1) | ND(2) | ND(2) | ND(2) | QC System Blank |
| Blank-28 | --- | --- | ND(1) | ND(1) | ND(1) | ND(2) | ND(2) | ND(2) | QC Rod Blank |
| DGW-124 | NE-24 | 24-25 | ND(1) | ND(1) | ND(1) | 55 | 19 | 278 | Groundwater Headspace |
| DSG-125 | SE-24 | 10-11 | ND(1) | ND(1) | ND(1) | ND(2) | ND(2) | ND(2) | Soil Gas |
| DSG-126 | SE-24 | 19-20 | ND(1) | ND(1) | ND(1) | 9 | ND(2) | ND(2) | Soil Gas |
| DGW-127 | SE-24 | 24-25 | ND(1) | ND(1) | ND(1) | 7 | ND(2) | ND(2) | Groundwater Headspace |
| DGW-127D | SE-24 | 24-25 | ND(1) | ND(1) | ND(1) | 7 | ND(2) | ND(2) | QC Duplicate (GWHS) |
| Blank-29 | --- | --- | ND(1) | ND(1) | ND(1) | ND(2) | ND(2) | ND(2) | QC System Blank |
| Blank-30 | --- | --- | ND(1) | ND(1) | ND(1) | ND(1) | ND(1) | ND(2) | QC System Blank |
| Blank-31 | --- | --- | ND(1) | 41 | ND(1) | ND(1) | ND(1) | ND(2) | QC Rod Blank |
| Blank-32 | --- | --- | 36 | ND(1) | ND(1) | ND(1) | ND(1) | ND(2) | QC Ambient Blank |
| DSG-128 | Bay I-6 | 0-1 | 4542 | ND(1) | 328 | 249 | 971 | 6347 | Soil Gas |
| DSG-129 | Bay I-6 | 3-4 | 4412 | ND(1) | 384 | 310 | 780 | 5340 | Soil Gas |
| DSG-130 | Bay I-6 | 6-7 | 13240 | ND(1) | 774 | 779 | 639 | 4459 | Soil Gas |
| DSG-131 | Bay G-1 | 7.5-8.5 | 9 | ND(1) | 6 | 8 | 93 | 461 | Soil Gas |
| DSG-132 | Bay G-1 | 19-20 | 315 | ND(1) | 13 | 16 | 175 | 733 | Soil Gas |
| DGW-133 | Bay G-1 | 24-25 | 11 | ND(1) | 57 | 43 | 2002 | 199 | Groundwater Headspace |
| DSG-134 | Bay G-10 | 7.5-8.5 | 607 | ND(1) | 8 | 176 | 175 | 104 | Soil Gas |
| DSG-135 | Bay G-10 | 19-20 | 32623 | ND(1) | 167 | 739 | 460 | 1905 | Soil Gas |
| DGW-136 | Bay G-10 | 24-25 | 418 | ND(1) | 14 | 452 | 85 | 474 | Groundwater Headspace |
| DGW-136D | Bay G-10 | 24-25 | 316 | ND(1) | 15 | 561 | 92 | 499 | QC Duplicate (GWHS) |
| Blank-33 | --- | --- | ND(1) | ND(1) | ND(1) | ND(1) | ND(1) | ND(2) | QC System Blank |
| Blank-34 | --- | --- | ND(1) | ND(1) | ND(1) | ND(2) | ND(2) | ND(2) | QC System Blank |
| Blank-35 | --- | --- | 77 | ND(1) | ND(1) | ND(2) | ND(2) | ND(2) | QC Rod Blank |
| DSG-137 | Bay J-7 | 7.5-8.5 | 10280 | ND(1) | 136 | 797 | 1086 | 196 | Soil Gas |
| Blank-36 | --- | --- | 198 | 147 | 49 | 64 | 51 | 27 | Ambient Air |

Table 1 (Continued)

RECON[SM] SAMPLE ANALYSIS SUMMARY
DATA SUMMARY TABLE

DAYTON THERMAL PRODUCTS DIVISION
ACUSTAR, INC.
DAYTON, OHIO

| Sample I.D. | Probe Hole Number | Depth (Feet) | 1,1-DCE (ug/L) | trans-1,2-DCE (ug/L) | cis-1,2-DCE (ug/L) | 1,1,1-TCA (ug/L) | TCE (ug/L) | PERC (ug/L) | Comments |
|---|---|---|---|---|---|---|---|---|---|
| DSG-138 | Bay J-7 | 19-20 | 25054 | ND(1) | 357 | 1000 | 1036 | 278 | Soil Gas |
| DGW-139 | Bay J-7 | 24-25 | 823 | ND(1) | 127 | 146 | 115 | 189 | Groundwater Headspace |
| DSG-140 | Bay J-3 | 0-1 | 185 | ND(1) | 21 | ND(2) | 40 | ND(2) | Soil Gas |
| DSG-141 | Bay J-3 | 3-4 | 3083 | ND(1) | 209 | 99 | 460 | ND(2) | Soil Gas |
| DSG-142 | Bay J-3 | 6-7 | 3214 | ND(1) | 234 | 123 | 614 | 10 | Soil Gas |
| DSG-143 | Bay J-4 | 0-1 | 7564 | ND(1) | 165 | 155 | 1092 | 36 | Soil Gas |
| DSG-144 | Bay J-4 | 3-4 | 10753 | ND(1) | 205 | 259 | 675 | 164 | Soil Gas |
| DSG-145 | Bay J-4 | 6-7 | 14520 | ND(1) | 212 | 348 | 781 | 174 | Soil Gas |
| DSG-145D | Bay J-4 | 6-7 | 14479 | ND(1) | 213 | 351 | 788 | 178 | QC Duplicate (SG) |
| Blank-37 | --- | --- | 14 | ND(1) | ND(1) | ND(2) | ND(2) | ND(2) | QC System Blank |
| Blank-38 | --- | --- | ND(1) | ND(1) | ND(1) | ND(2) | ND(2) | ND(2) | QC System Blank |
| Blank-39 | --- | --- | ND(1) | ND(1) | ND(1) | ND(2) | ND(2) | ND(2) | QC Rod Blank |
| DSG-146 | Bay I-5 | 0-1 | 7540 | ND(1) | 247 | 195 | 573 | 4212 | Soil Gas |
| DSG-147 | Bay I-5 | 3-4 | 12445 | ND(1) | 341 | 297 | 772 | 5959 | Soil Gas |
| DSG-148 | Bay I-5 | 6-7 | 17329 | ND(1) | 310 | 322 | 734 | 4357 | Soil Gas |
| DSG-149 | Bay I-7 | 0-1 | 262 | ND(1) | 32 | 38 | 67 | 525 | Soil Gas |
| DSG-150 | Bay I-7 | 3-4 | 2658 | ND(1) | 49 | 254 | 55 | 202 | Soil Gas |
| DSG-151 | Bay I-7 | 6-7 | 3811 | ND(1) | 68 | 402 | 58 | 186 | Soil Gas |
| DSG-152 | Bay I-8 | 0-1 | 237 | ND(1) | 33 | 66 | 65 | 184 | Soil Gas |
| DSG-153 | Bay I-8 | 3-4 | 907 | ND(1) | 7 | 121 | 68 | 81 | Soil Gas |
| DSG-154 | Bay I-8 | 6-7 | 1580 | ND(1) | 8 | 159 | 84 | 63 | Soil Gas |
| Blank-40 | --- | --- | ND(1) | ND(2) | ND(1) | ND(2) | ND(2) | ND(2) | QC System Blank |
| VOC B-1 | VOC Blower #3 | --- | ND(1) | ND(1) | ND(1) | ND(2) | 10 | ND(2) | Air Vent Sample |
| VOC B-2 | VOC Blower #4 | --- | ND(1) | ND(1) | ND(1) | ND(2) | ND(2) | ND(2) | Air Vent Sample |
| DSG-155 | Bay J-6 | 0-1 | 18464 | ND(1) | 480 | 1527 | 4071 | 952 | Soil Gas |
| DSG-156 | Bay J-6 | 3-4 | 19391 | ND(1) | 338 | 1159 | 2873 | 776 | Soil Gas |
| DSG-157 | Bay J-6 | 6-7 | 20790 | ND(1) | 173 | 676 | 1439 | 556 | Soil Gas |
| DSG-158 | Bay J-8 | 0-1 | 174 | ND(1) | 15 | 84 | 153 | 38 | Soil Gas |
| DSG-159 | Bay J-8 | 3-4 | 349 | ND(1) | 33 | 642 | 172 | 33 | Soil Gas |
| DSG-160 | Bay J-8 | 6-7 | 551 | ND(1) | 44 | 700 | 195 | 31 | Soil Gas |
| DSG-160D | Bay J-8 | 6-7 | 542 | ND(1) | 43 | 691 | 193 | 29 | QC Duplicate (SG) |

Table 1 (Continued)

RECON[SM] SAMPLE ANALYSIS SUMMARY
DATA SUMMARY TABLE

DAYTON THERMAL PRODUCTS DIVISION
ACUSTAR, INC.
DAYTON, OHIO

| Sample I.D. | Probe Hole Number | Depth (Feet) | 1,1-DCE (ug/L) | trans-1,2-DCE (ug/L) | cis-1,2-DCE (ug/L) | 1,1,1-TCA (ug/L) | TCE (ug/L) | PERC (ug/L) | Comments |
|---|---|---|---|---|---|---|---|---|---|
| Blank-41 | --- | --- | ND(1) | ND(1) | ND(1) | ND(2) | ND(2) | ND(2) | QC Blank |
| Blank-42 | --- | --- | ND(1) | ND(1) | ND(1) | ND(2) | ND(2) | ND(2) | QC System Blank |
| Blank-43 | --- | --- | ND(1) | ND(1) | ND(1) | ND(2) | ND(2) | ND(2) | QC Rod Blank |
| DSG-161 | LW-1 | 10-11 | ND(1) | ND(1) | ND(1) | ND(2) | ND(2) | ND(2) | Soil Gas |
| DSG-162 | LW-1 | 20-21 | 6 | ND(1) | ND(1) | ND(2) | 10 | ND(2) | Soil Gas |
| DGW-163 | LW-1 | 24-25 | ND(1) | ND(1) | ND(1) | ND(2) | 7 | ND(2) | Groundwater Headspace |
| DGW-164 | LW-1 | 30-31 | ND(1) | ND(1) | ND(1) | 6 | 10 | ND(2) | Groundwater Headspace (D) |
| DSG-165 | LW-2 | 10-11 | ND(1) | ND(1) | ND(1) | ND(2) | ND(2) | ND(2) | Soil Gas |
| DSG-166 | LW-2 | 20-21 | 7 | ND(1) | ND(1) | ND(2) | ND(2) | ND(2) | Soil Gas |
| DGW-167 | LW-2 | 24-25 | ND(1) | ND(1) | 5 | 13 | ND(2) | ND(2) | Groundwater Headspace |
| DSG-168 | LW-3 | 10-11 | ND(1) | ND(1) | ND(1) | ND(2) | ND(2) | ND(2) | Soil Gas |
| DSG-169 | LW-3 | 20-21 | ND(1) | ND(1) | 19 | ND(2) | 21 | ND(2) | Soil Gas |
| DGW-170 | LW-3 | 24-25 | ND(1) | 10 | 251 | ND(2) | 155 | ND(2) | Groundwater Headspace |
| DGW-170D | LW-3 | 24-25 | ND(1) | 3 | 269 | ND(2) | 159 | ND(2) | QC Duplicate (GWHS) |
| Blank-44A | --- | --- | ND(1) | ND(1) | ND(1) | ND(2) | ND(2) | ND(2) | QC Blank |
| DSG-171 | LW-4 | 10-11 | ND(1) | ND(1) | ND(1) | ND(2) | ND(2) | ND(2) | Soil Gas |
| DSG-172 | LW-4 | 20-21 | ND(1) | ND(1) | ND(1) | ND(2) | ND(2) | ND(2) | Soil Gas |
| DGW-173 | LW-4 | 24-25 | ND(1) | ND(1) | 27 | 11 | 86 | ND(2) | Groundwater Headspace |
| DSG-174 | VOC Blower #3 | --- | ND(1) | ND(1) | ND(1) | ND(2) | 12 | ND(2) | Soil Gas |
| DSG-175 | VOC Blower #4 | --- | ND(1) | ND(1) | ND(1) | ND(2) | 10 | ND(2) | Soil Gas |
| Blank-45 | --- | --- | ND(1) | ND(1) | ND(1) | ND(2) | ND(2) | ND(2) | QC System Blank |
| Blank-46 | --- | --- | ND(1) | ND(1) | ND(1) | ND(2) | ND(2) | ND(2) | QC System Blank |
| Blank-47 | --- | --- | ND(1) | ND(1) | ND(1) | ND(2) | ND(2) | ND(2) | QC Rod Blank |
| DSG-176 | MG-1 | 10-11 | ND(1) | ND(1) | ND(1) | ND(2) | ND(2) | ND(2) | Soil Gas |
| DSG-177 | MG-1 | 20-21 | ND(1) | ND(1) | ND(1) | ND(2) | ND(2) | 12 | Soil Gas |
| DGW-178 | MG-1 | 24-25 | ND(1) | ND(1) | ND(1) | ND(2) | ND(2) | 118 | Groundwater Headspace |
| DORF | TCA Tank | --- | 15 | ND(1) | ND(1) | 8184 | 11 | 19 | Water from Catch Basin |

Table 1 (Continued)

RECON[SM] SAMPLE ANALYSIS SUMMARY
DATA SUMMARY TABLE

DAYTON THERMAL PRODUCTS DIVISION
ACUSTAR, INC.
DAYTON, OHIO

| Sample I.D. | Probe Hole Number | Depth (Feet) | 1,1-DCE (ug/L) | trans-1,2-DCE (ug/L) | cis-1,2-DCE (ug/L) | 1,1,1-TCA (ug/L) | TCE (ug/L) | PERC (ug/L) | Comments |
|---|---|---|---|---|---|---|---|---|---|
| DSG-179 | LD-1 | 10-11 | 12 | ND(1) | ND(1) | 1775 | 22 | 292 | Soil Gas |
| DSG-180 | LD-1 | 20-21 | 30 | ND(1) | 10 | 9020 | 21 | 1150 | Soil Gas |
| DGW-181 | LD-1 | 24-25 | ND(1) | ND(1) | ND(1) | 261 | ND(2) | 68 | Groundwater Headspace |
| DSG-182 | NEL-2 | 10-11 | ND(1) | ND(1) | ND(1) | 9 | ND(2) | 14 | Soil Gas |
| DSG-183 | NEL-2 | 20-21 | ND(1) | ND(1) | ND(1) | 32 | 12 | 43 | Soil Gas |
| DGW-184 | NEL-2 | 24-25 | ND(1) | ND(1) | ND(1) | 38 | 9 | 59 | Groundwater Headspace |
| DGW-184D | NEL-2 | 24-25 | ND(1) | ND(1) | ND(1) | 37 | 10 | 57 | QC Duplicate (GWHS) |
| Blank-48 | --- | --- | ND(1) | ND(1) | ND(1) | ND(2) | ND(2) | ND(2) | QC Blank |
| Blank-49 | --- | --- | ND(2) | ND(2) | ND(2) | ND(2) | ND(2) | ND(2) | QC System Blank |
| Blank-50 | --- | --- | ND(2) | ND(2) | ND(2) | ND(2) | ND(2) | ND(2) | QC Rod Blank |
| DSG-185 | LD-2 | 10-11 | 26 | ND(2) | 7 | 4463 | 56 | 786 | Soil Gas |
| DGW-186 | LD-2 | 24-25 | 270 | ND(2) | 13 | 33786 | 118 | 1149 | Groundwater Headspace |
| DSG-187 | MG-2 | 10-11 | ND(2) | ND(2) | ND(2) | 9 | ND(2) | ND(2) | Soil Gas |
| DSG-188 | MG-2 | 20-21 | ND(2) | ND(2) | ND(2) | 12 | ND(2) | 11 | Soil Gas |
| DGW-189 | MG-2 | 24-25 | ND(2) | ND(2) | ND(2) | ND(2) | ND(2) | ND(2) | Groundwater Headspace |
| DGW-190 | PH-07D | 24-25 | ND(2) | ND(2) | 24 | 16 | 22 | 26 | Groundwater Headspace |
| DGW-190D | PH-07D | 24-25 | ND(2) | ND(2) | 31 | 20 | 26 | 29 | QC Duplicate (GWHS) |
| Blank-51 | --- | --- | ND(2) | ND(2) | ND(2) | ND(2) | ND(2) | ND(2) | QC System Blank |
| Blank-52 | --- | --- | ND(1) | ND(1) | ND(1) | ND(2) | ND(2) | ND(2) | QC System Blank |
| Blank-53 | --- | --- | ND(1) | ND(1) | ND(1) | ND(2) | ND(2) | ND(2) | QC Rod Blank |
| DGW-191 | PL-24 | 24-25 | ND(1) | ND(1) | ND(1) | ND(2) | ND(2) | ND(2) | Groundwater Headspace |
| DGW-191D | PL-24 | 24-25 | ND(1) | ND(1) | ND(1) | ND(2) | ND(2) | ND(2) | QC Duplicate (GWHS) |
| DGW-192 | PL-24 | 30-31 | ND(1) | ND(1) | 62 | ND(2) | 1349 | ND(2) | Groundwater Headspace (D) |
| Blank-54 | --- | --- | ND(1) | ND(1) | ND(1) | ND(2) | 20 | ND(2) | QC System Blank |
| DGW-193 | WW-1 | 10-11 | ND(1) | ND(1) | ND(1) | ND(2) | ND(2) | ND(2) | Soil Gas |
| DSG-194 | WW-1 | 20-21 | ND(1) | ND(1) | ND(1) | ND(2) | ND(2) | ND(2) | Soil Gas |
| DGW-195 | WW-1 | 24-25 | ND(1) | ND(1) | ND(1) | ND(2) | ND(2) | ND(2) | Groundwater Headspace |

D - Groundwater sample collected at 30 to 31 feet below the surface.
GWHS - Groundwater headspace analysis.
ND - Not Detected above 1 or 2 parts per billion background.

QC - Quality control.
SG - Soil gas analysis.
ug/L - microgram/Liter.

Table 2

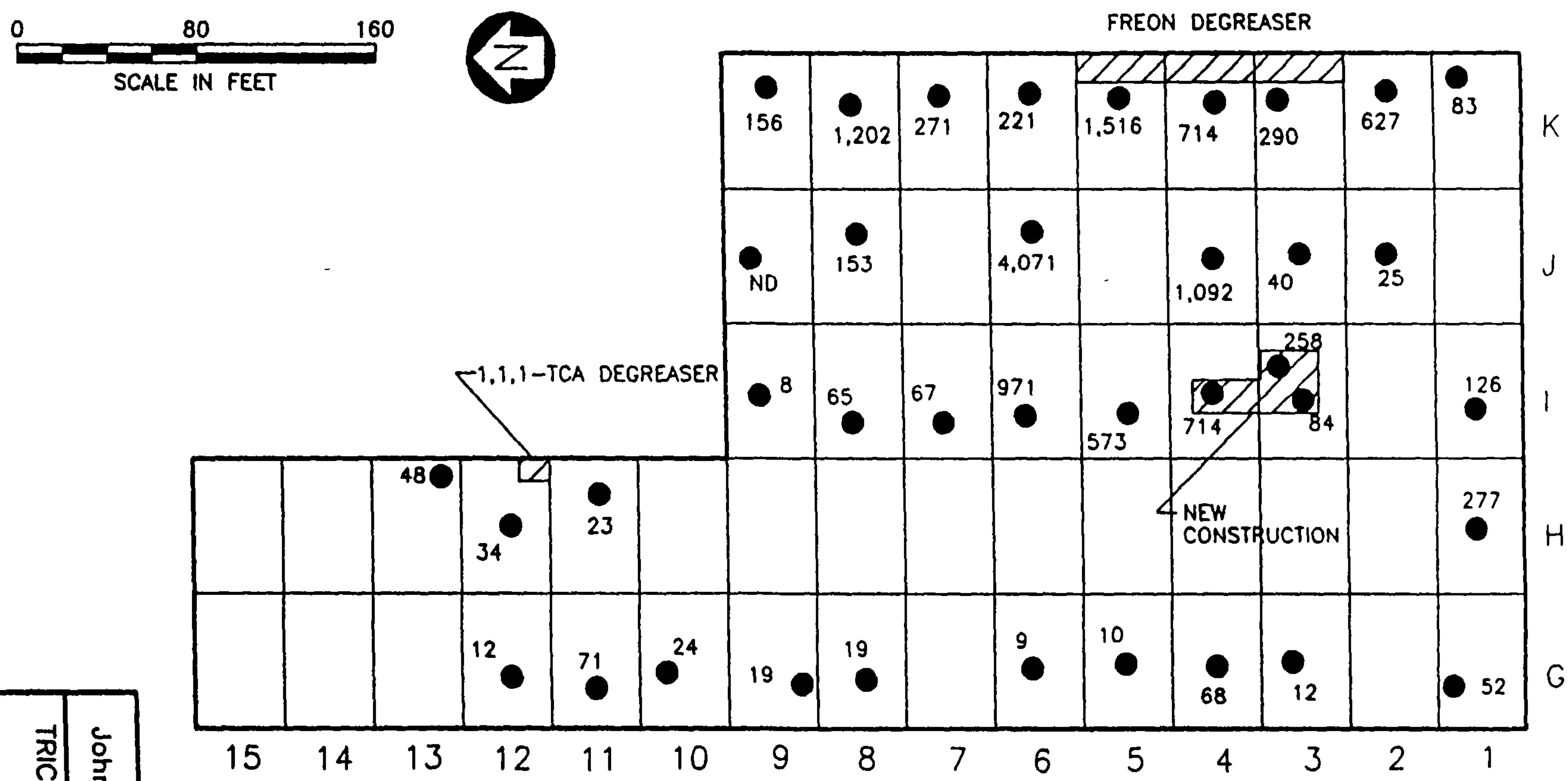
ANLYTICAL RESULTS - VOC ANALYSES
GROUNDWATER SAMPLES COLLECTED USING RECON$^{SM}$

ACUSTAR, INC.
DAYTON THERMAL PRODUCTS, INC.

| Location | Chloroform | 1,1-DCA | 1,2-DCA | 1,1-DCE | t-1,2-DCE | Tetrachloroethene | 1,1,1-TCA | 1,1,2-TCA | TCE | Xylenes |
|---|---|---|---|---|---|---|---|---|---|---|
| WW-1 | ND<5 | ND<5 | ND<5 | ND<5 | ND<5 | ND<5 | ND<5 | ND<5 | ND<5 | ND<5 |
| PL-24 | ND<5 | ND<5 | ND<5 | ND<5 | ND<5 | ND<5 | ND<5 | ND<5 | 11 | ND<5 |
| PL-24 (2) | ND<5 | ND<5 | ND<5 | ND<5 | ND<5 | ND<5 | ND<5 | ND<5 | ND<5 | ND<5 |
| PH-03 | 5.4 | 400 | 42.7 | 42.8 | 700 | 12.9 | 500 | 17.9 | 900 | ND<5 |
| PH-04A | ND<5 | 400 | 6.8 | 19 | 600 | ND<5 | 500 | 9.6 | 800 | ND<5 |
| PH-04B | ND<5 | 300 | 13 | 18.9 | 600 | 6.9 | 500 | 8.6 | 700 | ND<5 |
| PH-06 | 7.3 | 65 | ND<5 | ND<5 | 200 | 21 | 400 | 14 | 400 | ND<5 |
| PH-7D | ND<5 | 8.3 | ND<5 | ND<5 | ND<5 | 390 | 160 | ND<5 | 430 | ND<5 |
| GW-1W | ND<5 | 5.8 | ND<5 | ND<5 | ND<5 | 200 | 75 | ND<5 | 700 | ND<5 |
| GW-10W | 5.9 | 89 | ND<5 | ND<5 | ND<5 | 220 | 270 | ND<5 | 130 | ND<5 |
| J-724 | ND<25 | 180 | ND<25 | ND<25 | ND<25 | 68 | 120 | ND<25 | 122 | ND<25 |
| NE-24 | ND<5 | ND<5 | ND<5 | ND<5 | ND<5 | 200 | 100 | ND<5 | 55 | ND<5 |
| NEL-2 | ND<5 | ND<5 | ND<5 | ND<5 | ND<5 | 190 | 63 | ND<5 | 59 | ND<5 |
| SE-24 | ND<5 | ND<5 | ND<5 | ND<5 | ND<5 | ND<5 | 21 | 5 | 15 | ND<5 |
| MG-1 | ND<5 | ND<5 | ND<5 | ND<5 | ND<5 | 310 | ND<5 | ND<5 | ND<5 | ND<5 |
| MG-2 | ND<5 | ND<5 | ND<5 | ND<5 | ND<5 | ND<5 | ND<5 | ND<5 | ND<5 | ND<5 |
| LD-2 | ND<5 | 2,500 | 280 | 360 | ND<5 | 470 | 1,200 | 9.6 | 140 | ND<5 |
| LW-124 | ND<5 | ND<5 | ND<5 | ND<5 | ND<5 | ND<5 | 28 | ND<5 | 180 | ND<5 |
| LW-130 | ND<5 | ND<5 | ND<5 | ND<5 | ND<5 | ND<5 | 31 | ND<5 | 150 | ND<5 |
| LW-224 | 8.2 | 130 | ND<5 | ND<5 | ND<5 | 7.8 | 45 | ND<5 | 29 | 6.7 |
| LW-324 | ND<5 | ND<5 | ND<5 | ND<5 | ND<5 | ND<5 | ND<5 | ND<5 | 400 | ND<5 |
| LW-330 | ND<5 | ND<5 | ND<5 | ND<5 | ND<5 | ND<5 | ND<5 | ND<5 | 2,000 | ND<5 |
| LW-424 | ND<5 | 33 | ND<5 | 15 | 13 | ND<5 | 130 | 12 | 800 | ND<5 |

1,1-DCA - 1,1-dichloroethane.
1,2-DCA - 1,2-dichloroethane.
1,1-DCE - 1,1-dichloroethene.
1,2-DCE - 1,2-dichloroethene.
t-1,2-DCE - trans-1,2-dichloroethene.
1,1,1-TCA - 1,1,1-trichloroethane.

| C REV. DATE 5/15/91 | DRAWN BY | TAA 6-25-91 | CHECKED BY | DTS 6/25/91 | DOCUMENT MANAGER | SE 6/26/91 | PROJECT MANAGER | 6/26/91 |
|---|---|---|---|---|---|---|---|---|




EXPLANATION

● 156 APPROXIMATE RECON℠ SAMPLE LOCATION, AND COMPOUND CONCENTRATION IN ug/L

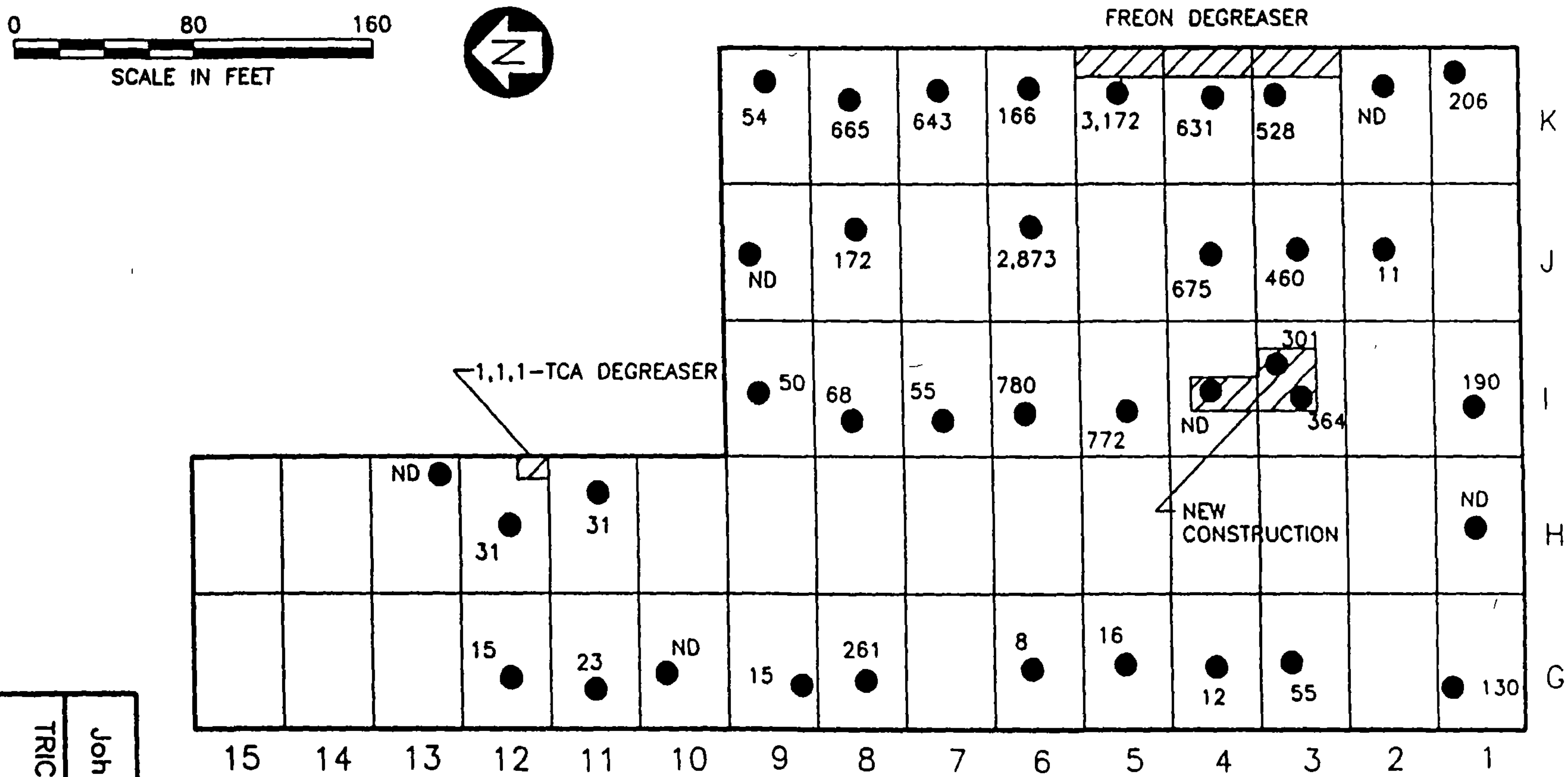
John Mathes & Associates, Inc.

TRICHLOROETHENE CONCENTRATION (ug/L) IN SOIL GAS AT 0 TO 1 FOOT BUILDINGS 40A AND 40B

ACUSTAR DAYTON, OHIO 423023

FIGURE 2

| C REV. DATE 5/15/91 | DRAWN BY | 6.25.91 | CHECKED BY | PTS 6/25/91 | DOCUMENT MANAGER | SG 6/26/91 | PROJECT MANAGER | |
|---|---|---|---|---|---|---|---|---|




EXPLANATION

● 54 APPROXIMATE RECON℠ SAMPLE LOCATION, AND COMPOUND CONCENTRATION IN ug/L

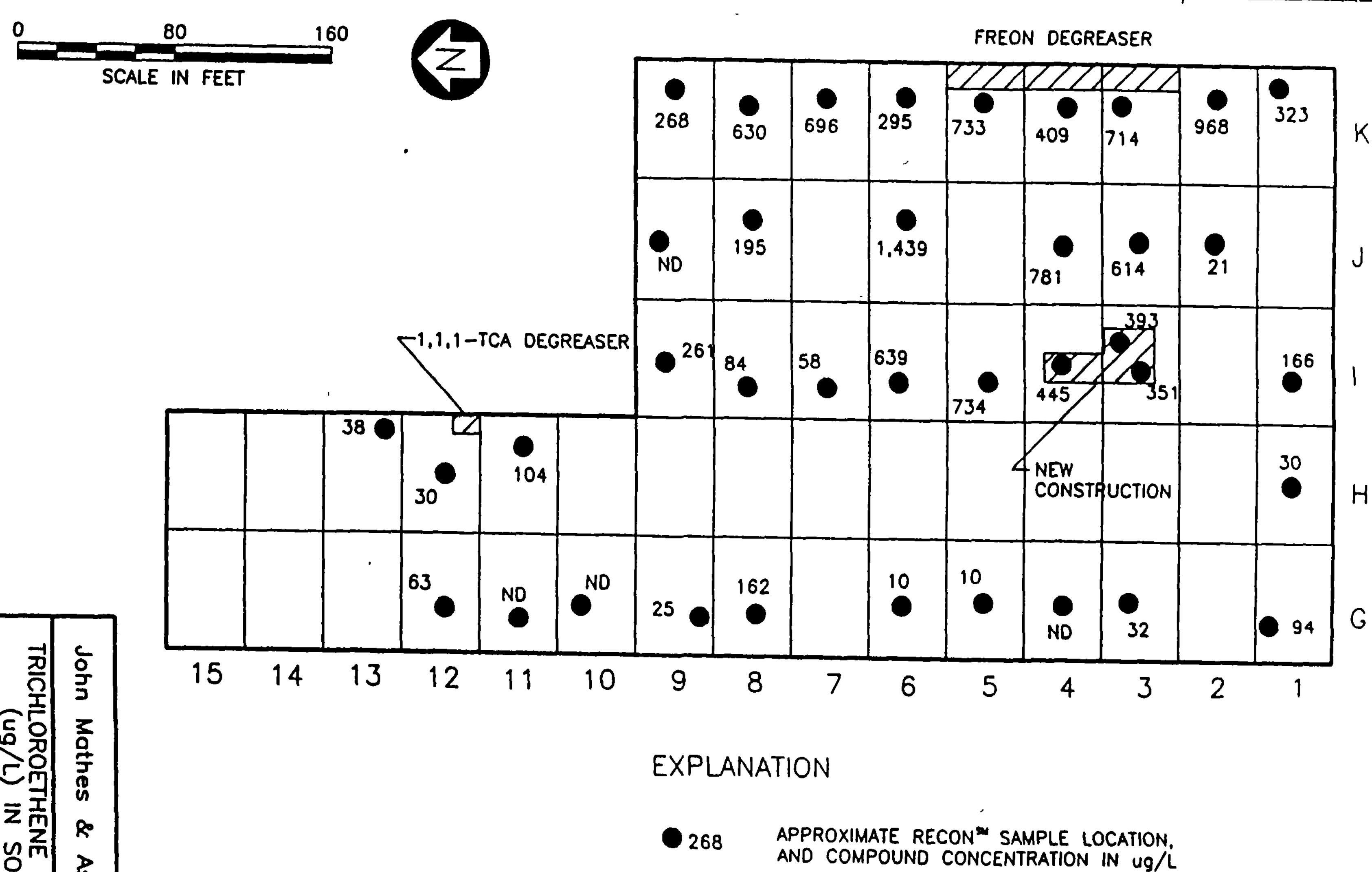
John Mathes & Associates, Inc.

TRICHLOROETHENE CONCENTRATION (ug/L) IN SOIL GAS AT 3 TO 4 FEET
BUILDINGS 40A AND 40B

ACUSTAR
DAYTON, OHIO
423023

FIGURE 3

| REV. DATE C 5/15/91 | DRAWN BY | TJM 6-25-91 | CHECKED BY | DHS 6/25/91 | DOCUMENT MANAGER | SLO 6/26/91 | PROJECT MANAGER | 6/21/.. |
|---|---|---|---|---|---|---|---|---|



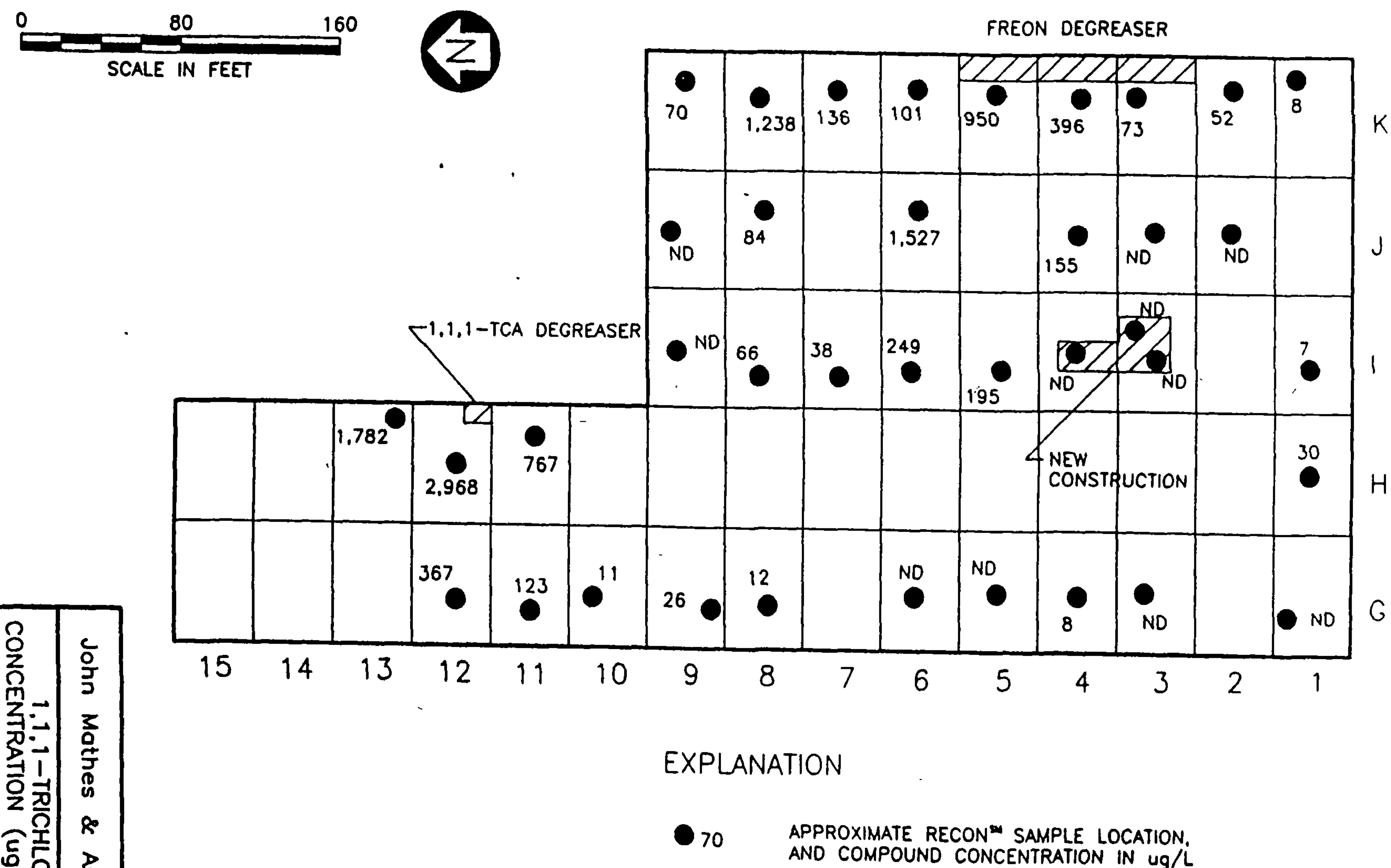

John Mathes & Associates, Inc.

TRICHLOROETHENE CONCENTRATION (ug/L) IN SOIL GAS AT 6 TO 7 FEET BUILDINGS 40A AND 40B

ACUSTAR
DAYTON, OHIO
423023

FIGURE 4

| REV. DATE | DRAWN BY | | CHECKED BY | | DOCUMENT MANAGER | | PROJECT MANAGER | |
|---|---|---|---|---|---|---|---|---|
| C 5/15/91 | | T.M. 6-25-91 | | PTS 6/25/91 | | SG 6/26/91 | | [illegible] |

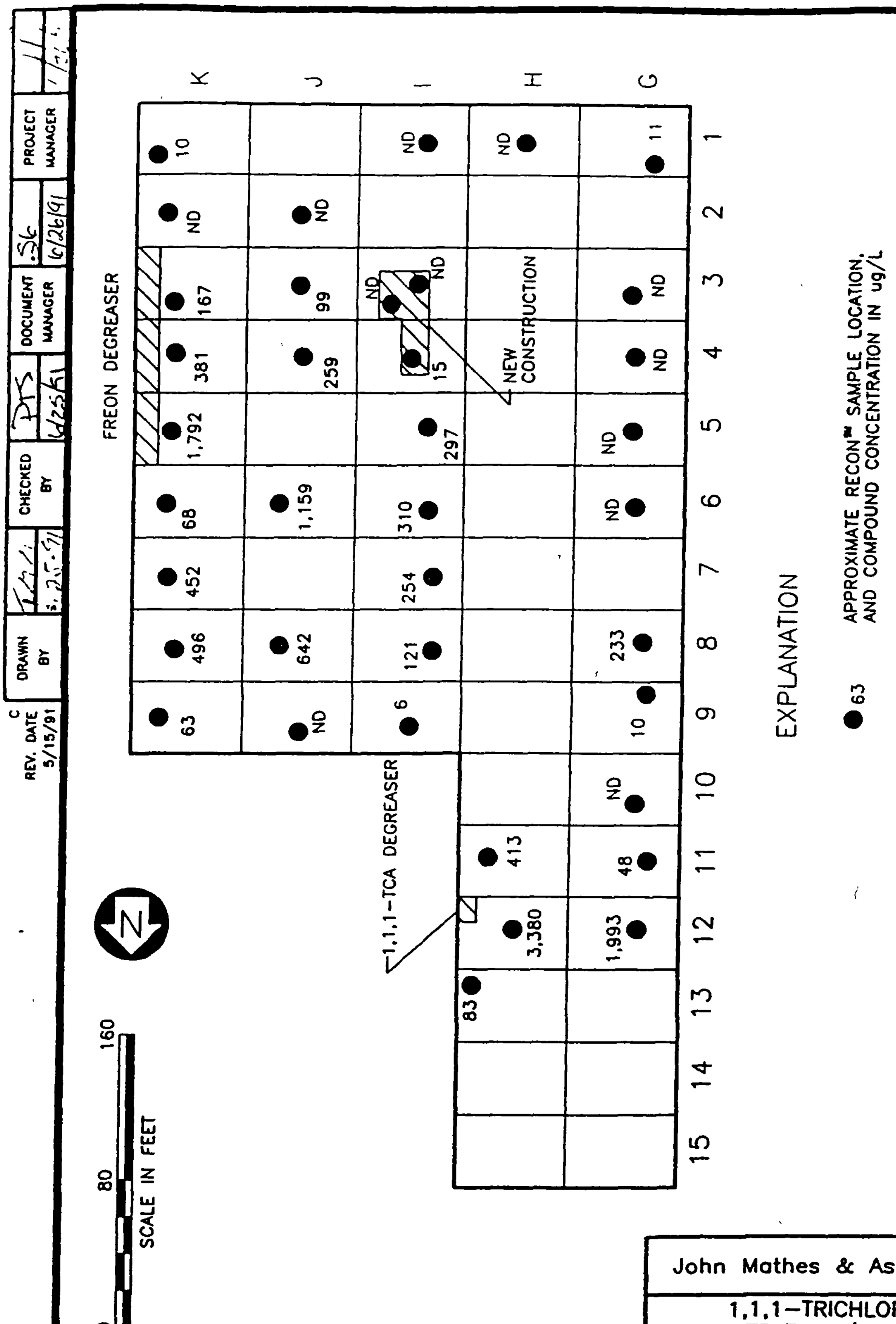



John Mathes & Associates, Inc.

1,1,1-TRICHLOROETHANE CONCENTRATION (ug/L) IN SOIL GAS AT 0 TO 1 FOOT BUILDINGS 40A AND 40B

ACUSTAR
DAYTON, OHIO
423023

FIGURE 5

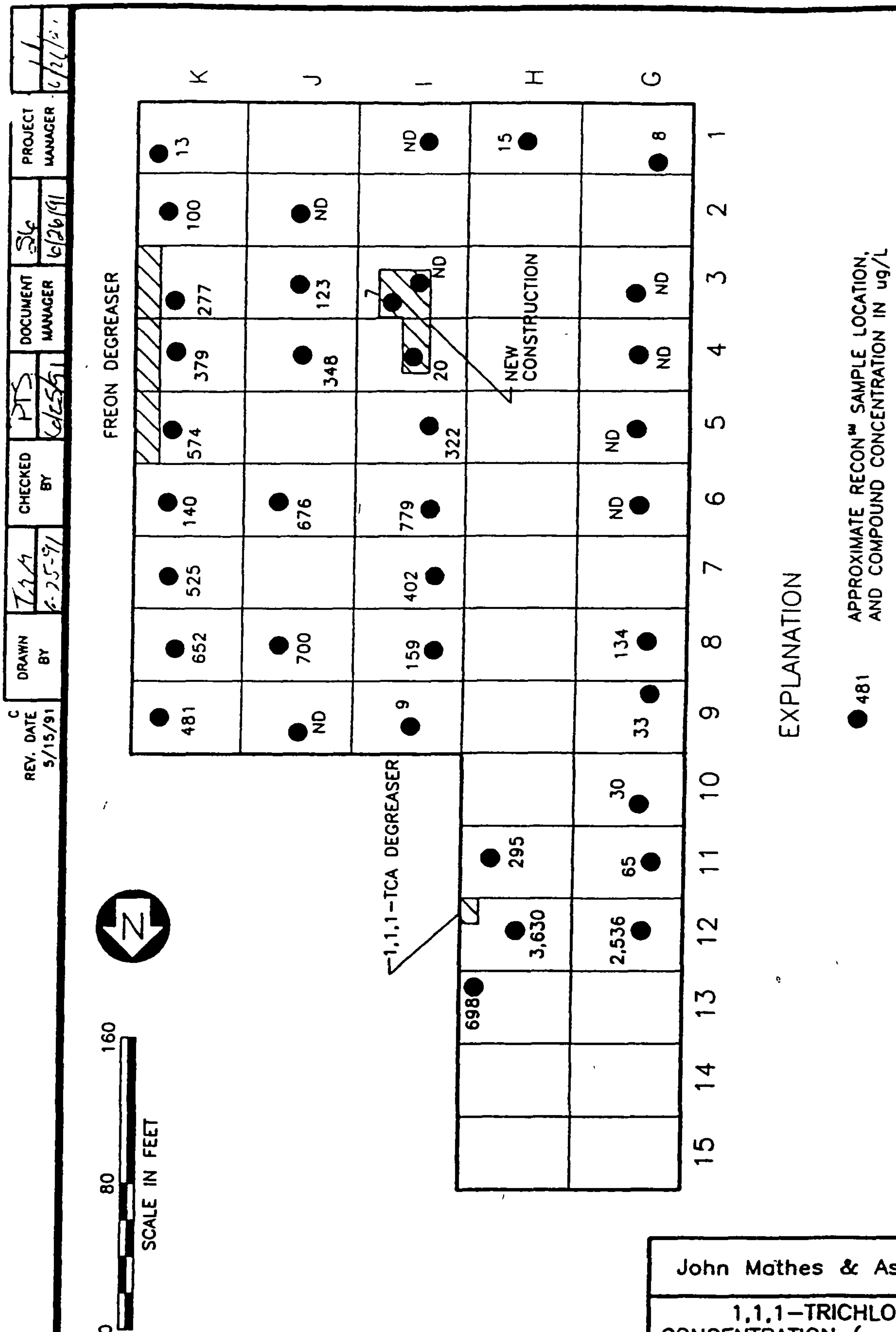



John Mathes & Associates, Inc.

1,1,1–TRICHLOROETHANE CONCENTRATION (ug/L) IN SOIL GAS AT 3 TO 4 FEET BUILDINGS 40A TO 40B

ACUSTAR
DAYTON, OHIO
423023

FIGURE 6




John Mathes & Associates, Inc.

1,1,1-TRICHLOROETHANE CONCENTRATION (ug/L) IN SOIL GAS AT 6 TO 7 FEET BUILDINGS 40A AND 40B

ACUSTAR
DAYTON, OHIO
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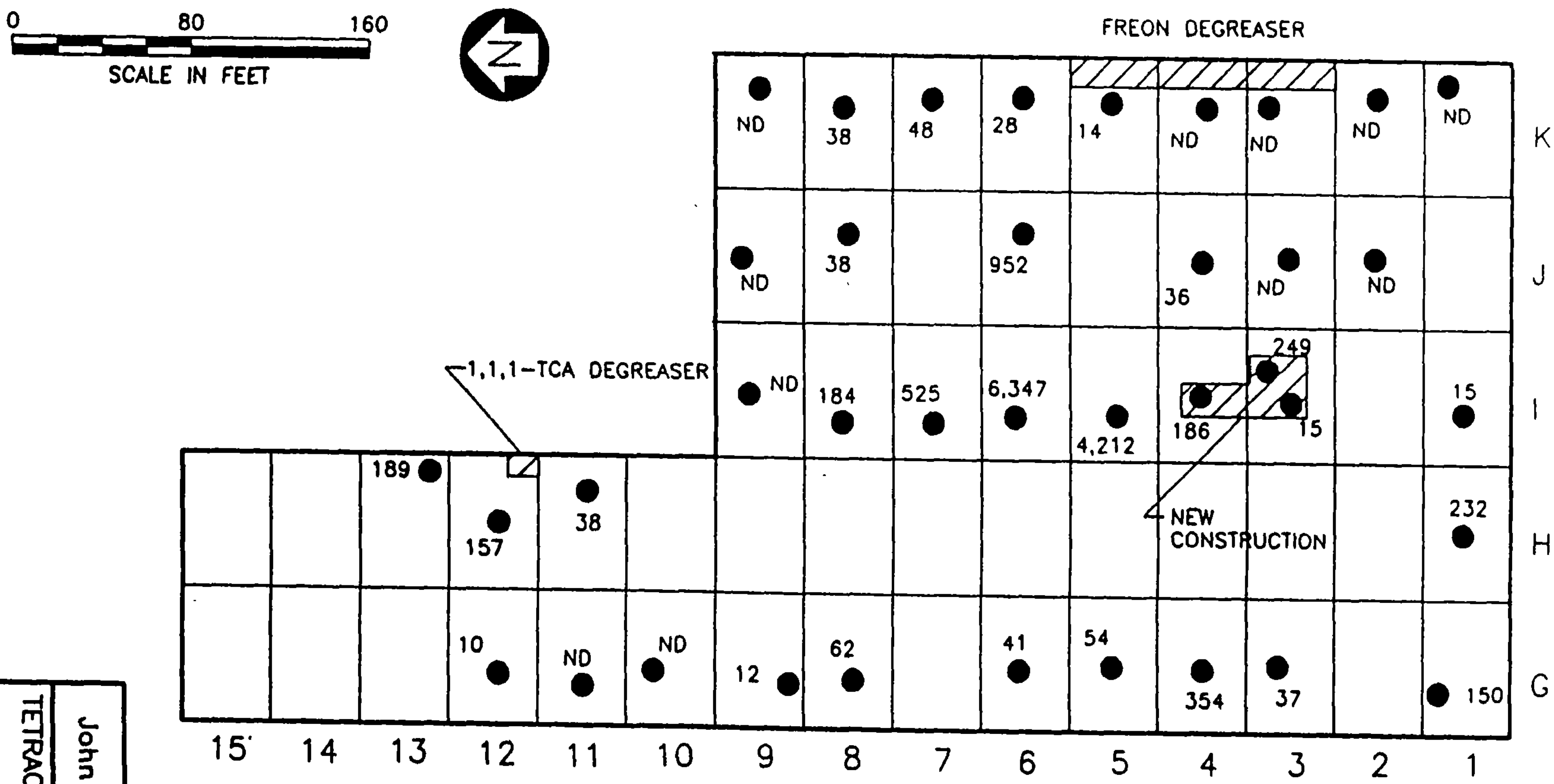
FIGURE 7

| C REV. DATE 5/15/91 | DRAWN BY | 7.7.91 6.25.91 | CHECKED BY | PTS 6/25/91 | DOCUMENT MANAGER | SG 6/26/91 | PROJECT MANAGER | |
|---|---|---|---|---|---|---|---|---|




EXPLANATION

● ND APPROXIMATE RECON℠ SAMPLE LOCATION, AND COMPOUND CONCENTRATION IN ug/L

**John Mathes & Associates, Inc.**

TETRACHLOROETHENE CONCENTRATION (ug/L) IN SOIL GAS AT 0 TO 1 FOOT BUILDINGS 40A AND 40B.

ACUSTAR
DAYTON, OHIO
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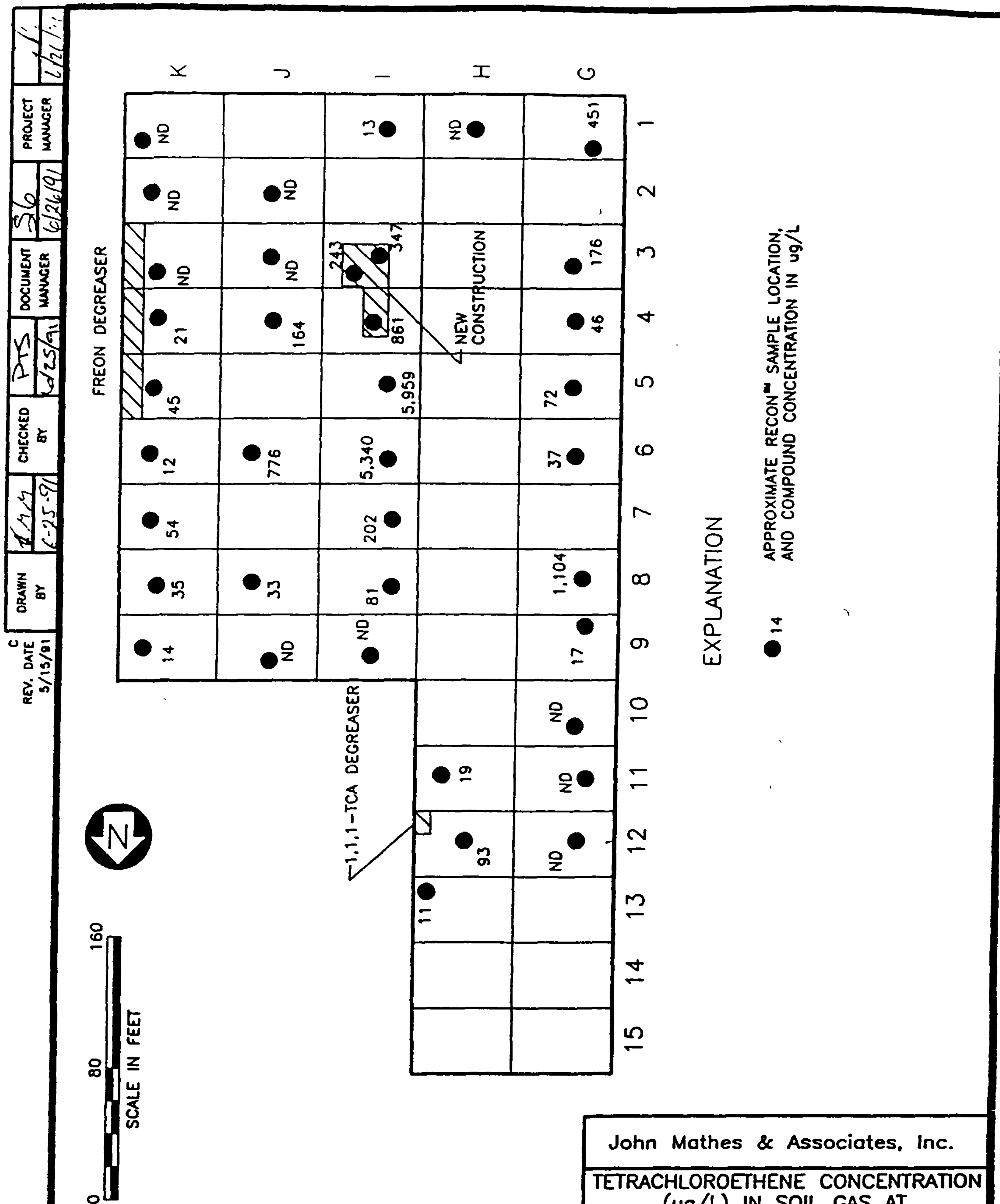
FIGURE 8




John Mathes & Associates, Inc.

TETRACHLOROETHENE CONCENTRATION (ug/L) IN SOIL GAS AT 3 TO 4 FEET BUILDINGS 40A AND 40B

ACUSTAR
DAYTON, OHIO
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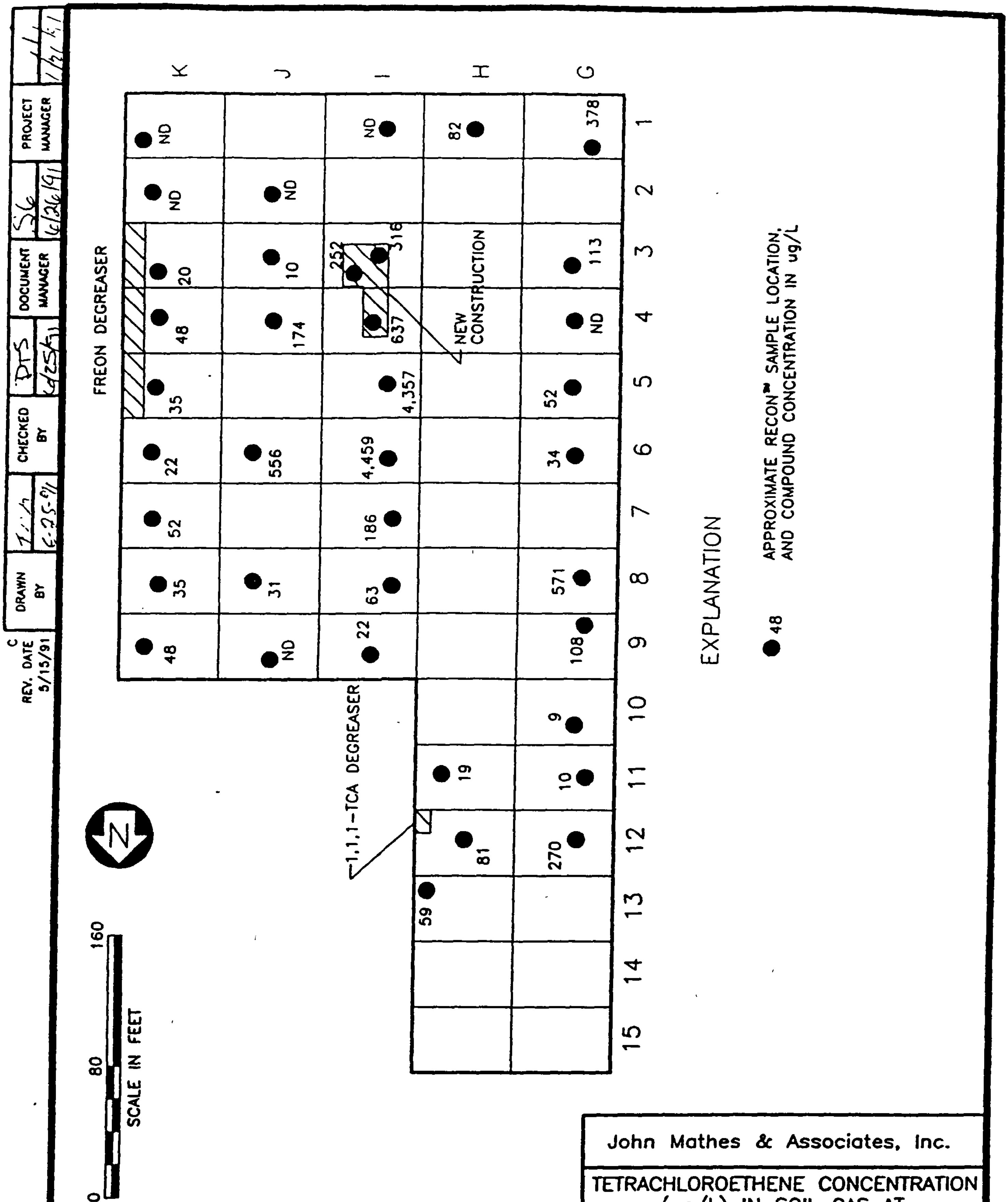
FIGURE 9

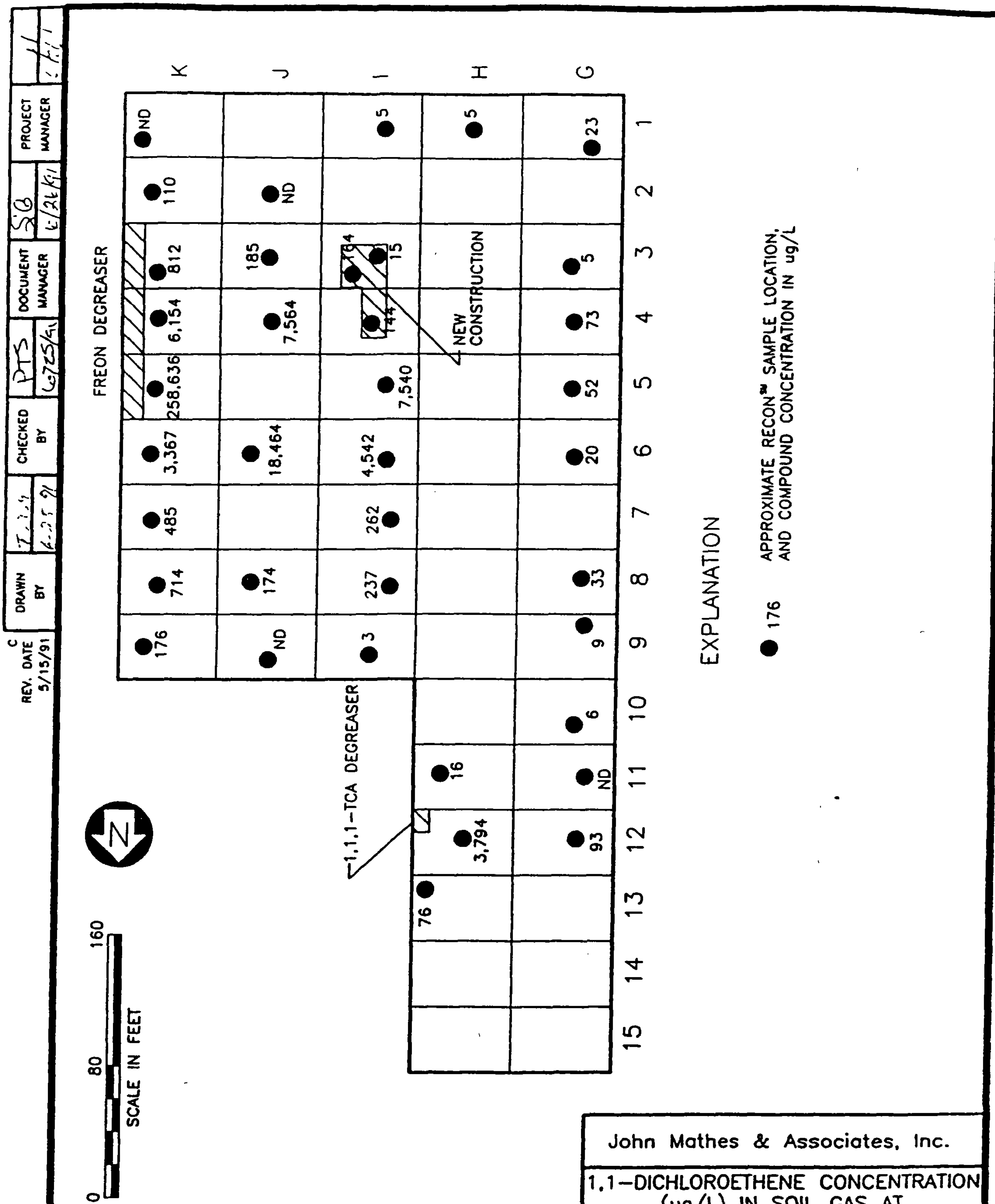



John Mathes & Associates, Inc.

TETRACHLOROETHENE CONCENTRATION (ug/L) IN SOIL GAS AT 6 TO 7 FEET BUILDINGS 40A AND 40B

ACUSTAR
DAYTON, OHIO
423023

FIGURE 10



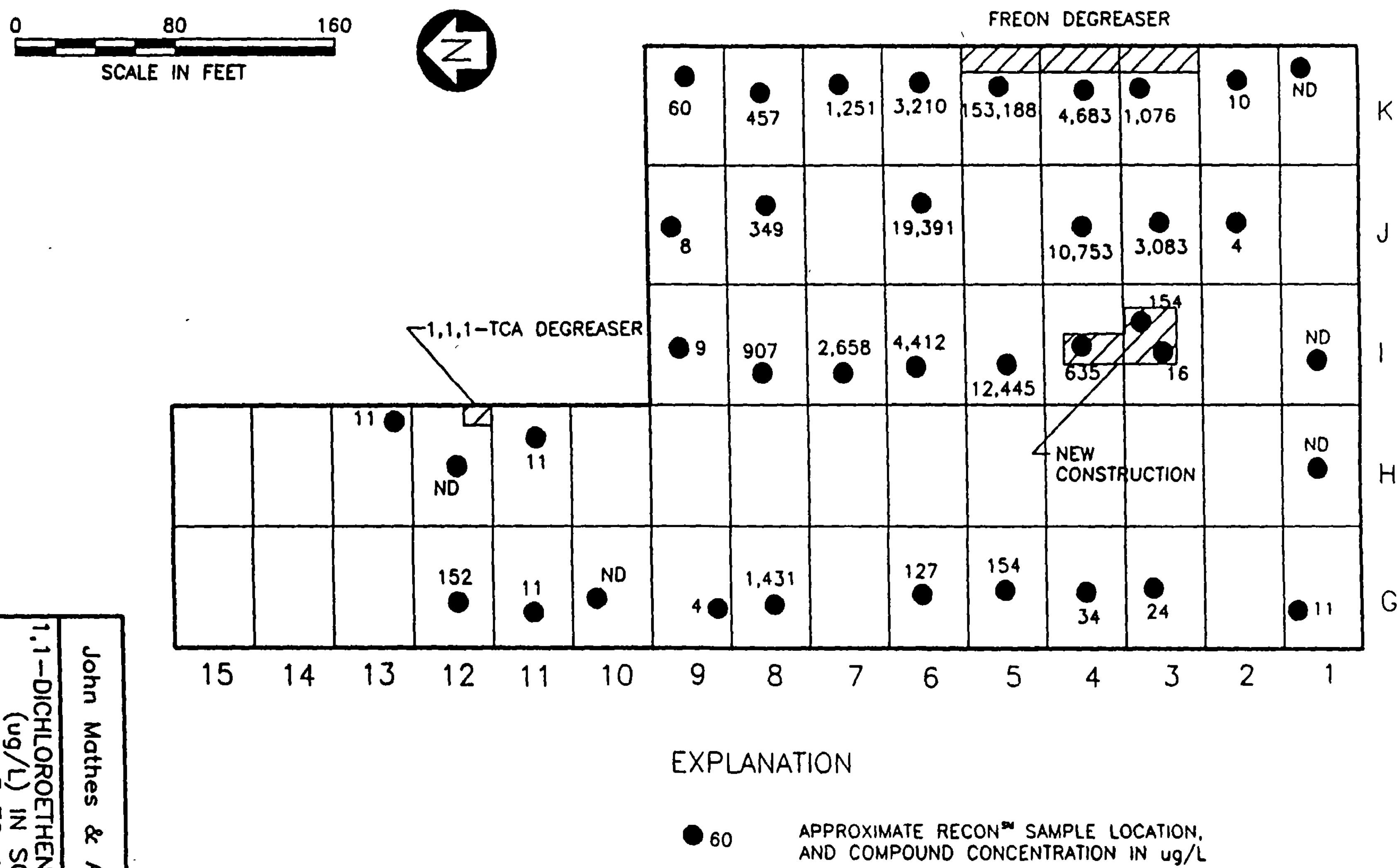

John Mathes & Associates, Inc.

1,1-DICHLOROETHENE CONCENTRATION (ug/L) IN SOIL GAS AT 0 TO 1 FOOT BUILDINGS 40A AND 40B

ACUSTAR
DAYTON, OHIO
423023

FIGURE 11

| REV. | DATE | DRAWN BY | | CHECKED BY | | DOCUMENT MANAGER | | PROJECT MANAGER | |
|---|---|---|---|---|---|---|---|---|---|
| C | 5/15/91 | [illegible] | 6.25.91 | PTS | 6/25/91 | SG | 6/26/91 | [illegible] | 6/21/91 |




John Mathes & Associates, Inc.

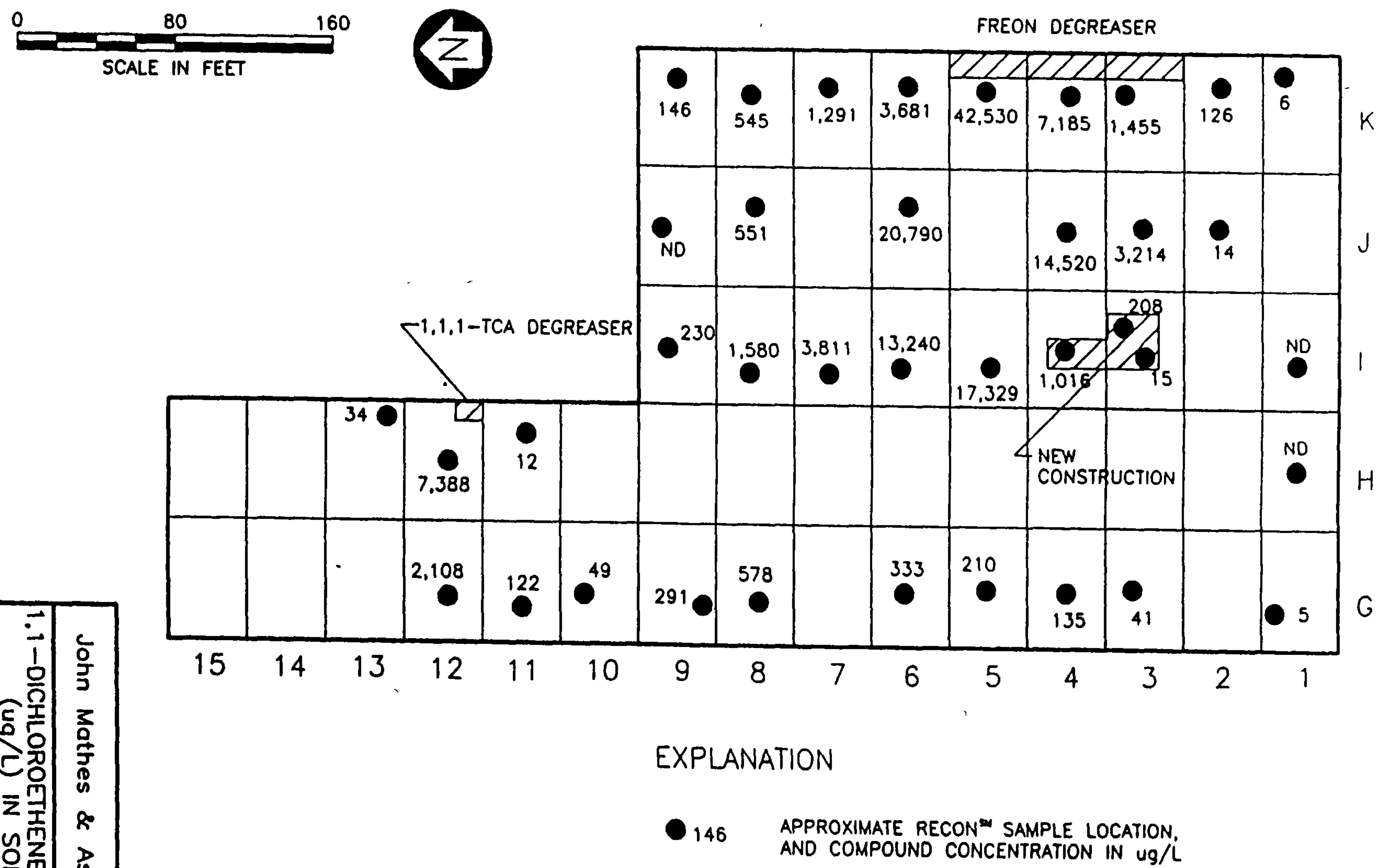
1,1-DICHLOROETHENE CONCENTRATION (ug/L) IN SOIL GAS AT 3 TO 4 FEET

BUILDINGS 40A AND 40B

ACUSTAR
DAYTON, OHIO
423023

FIGURE 12

| REV. | DATE | DRAWN BY | | CHECKED BY | | DOCUMENT MANAGER | | PROJECT MANAGER | |
|---|---|---|---|---|---|---|---|---|---|
| C | 5/15/91 | | 6-25-91 | PTS | 6/25/91 | SG | 6/26/91 | | |




John Mathes & Associates, Inc.

1,1-DICHLOROETHENE CONCENTRATION (ug/L) IN SOIL GAS AT 6 TO 7 FEET BUILDINGS 40A AND 40B

ACUSTAR
DAYTON, OHIO
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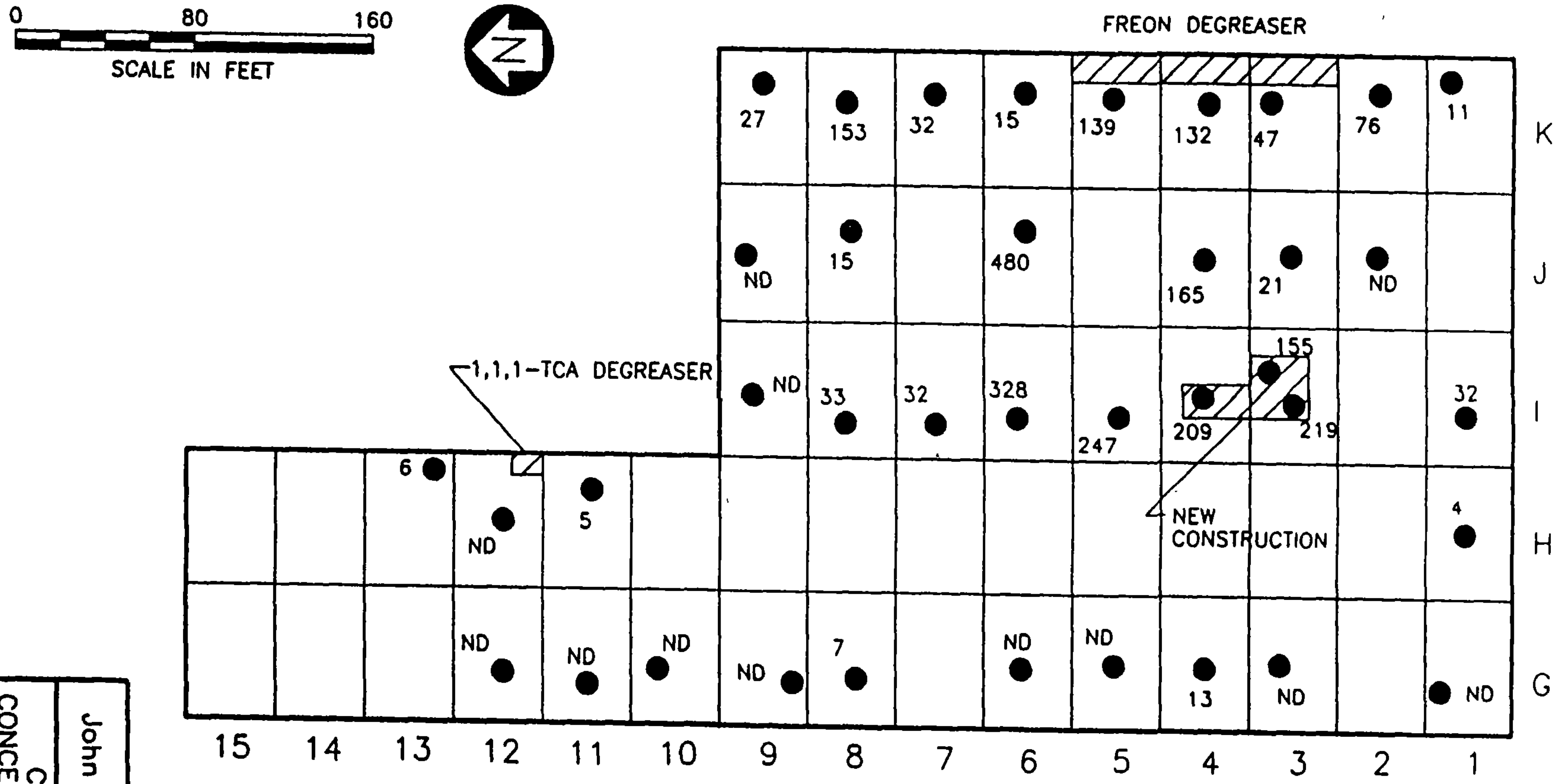
FIGURE 13

| REV. C DATE 5/15/91 | DRAWN BY | TMA 6-25-91 | CHECKED BY | DTS 6/25/91 | DOCUMENT MANAGER | SG 6/26/91 | PROJECT MANAGER | [illegible] 6/21/91 |
|---|---|---|---|---|---|---|---|---|




EXPLANATION

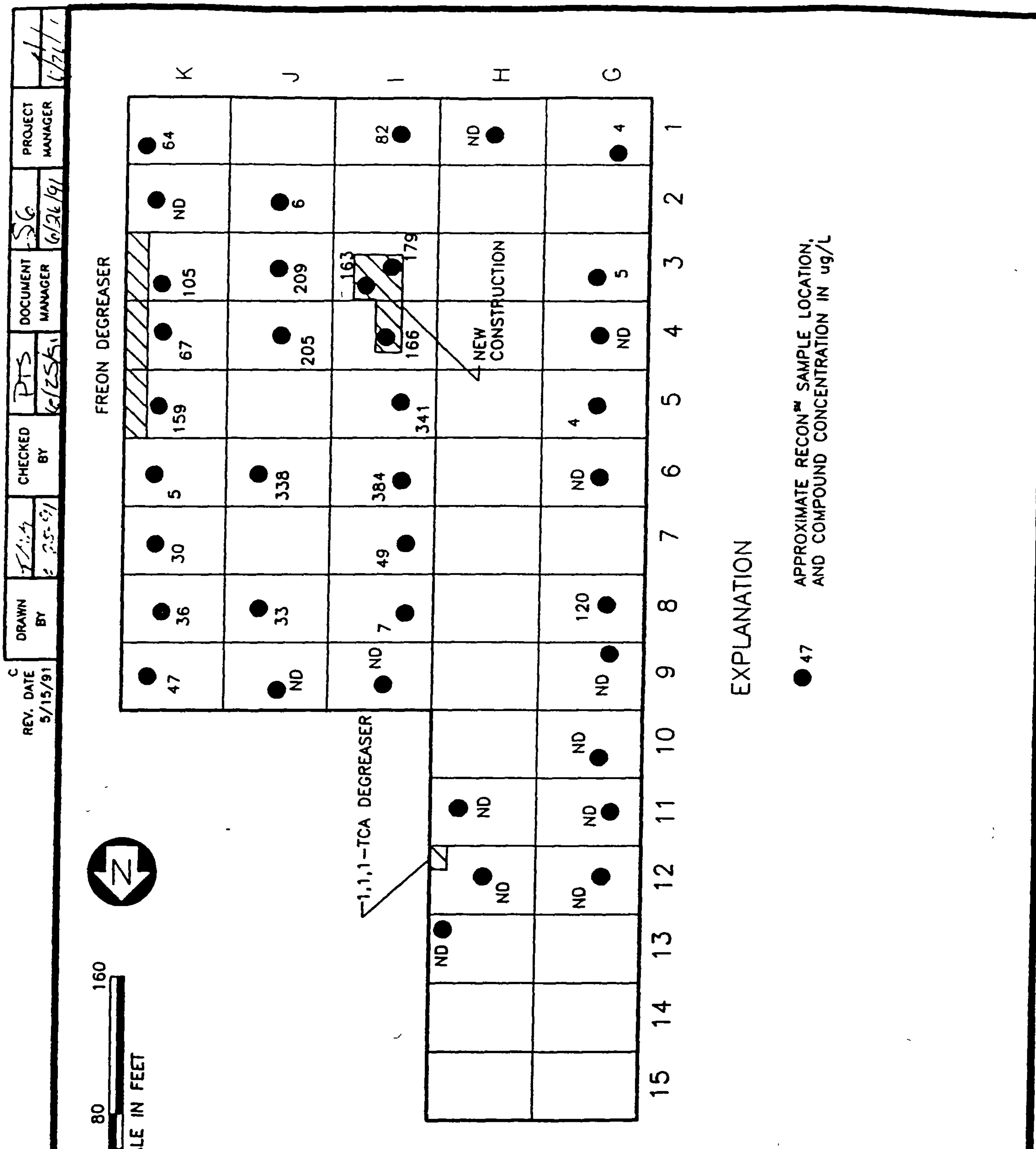
● 27 APPROXIMATE RECON℠ SAMPLE LOCATION, AND COMPOUND CONCENTRATION IN ug/L

John Mathes & Associates, Inc.

CIS-1,2-DICHLOROETHENE CONCENTRATION (ug/L) IN SOIL GAS AT 0 TO 1 FOOT BUILDINGS 40A AND 40B

ACUSTAR
DAYTON, OHIO
423023

FIGURE 14



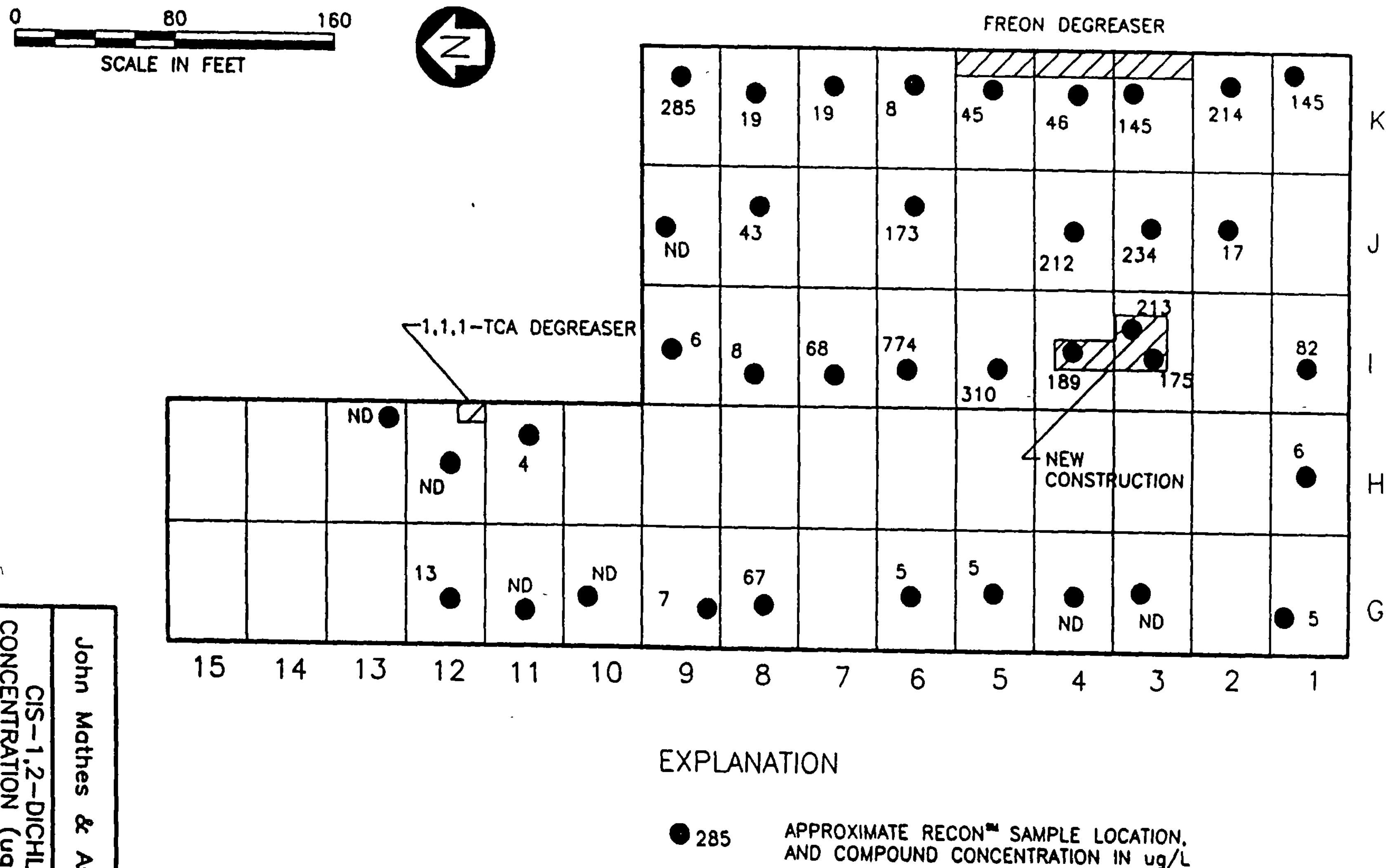

John Mathes & Associates, Inc.

CIS-1,2-DICHLOROETHENE CONCENTRATION (ug/L) IN SOIL GAS AT 3 TO 4 FEET BUILDINGS 40A AND 40B

ACUSTAR
DAYTON, OHIO
423023

FIGURE 15

| REV. DATE | DRAWN BY | | CHECKED BY | | DOCUMENT MANAGER | | PROJECT MANAGER | |
|---|---|---|---|---|---|---|---|---|
| C 5/15/91 | | 6-25-91 | | 6/25/91 | | 6/26/91 | | 6/21/91 |



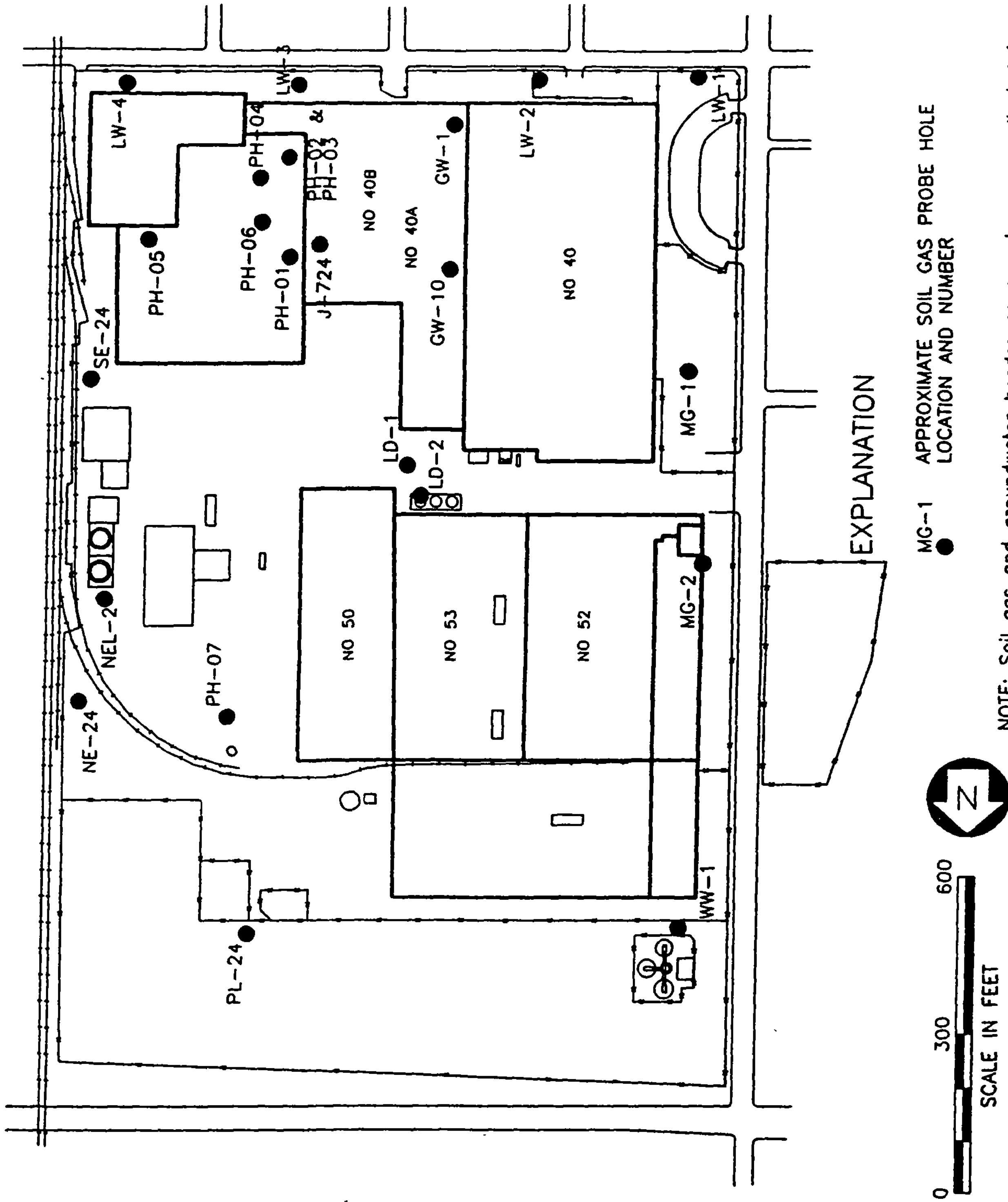

John Mathes & Associates, Inc.

CIS-1,2-DICHLOROETHENE CONCENTRATION (ug/L) IN SOIL GAS AT 6 TO 7 FEET BUILDINGS 40A AND 40B

ACUSTAR
DAYTON, OHIO
423023

FIGURE 16

| REV. | DATE | DRAWN BY | CHECKED BY | DOCUMENT MANAGER | PROJECT MANAGER |
|---|---|---|---|---|---|
| B | 5/15/91 | TMM 5-17-91 | PTS 5/17/91 | SO 5-20-91 | 5/20/91 |



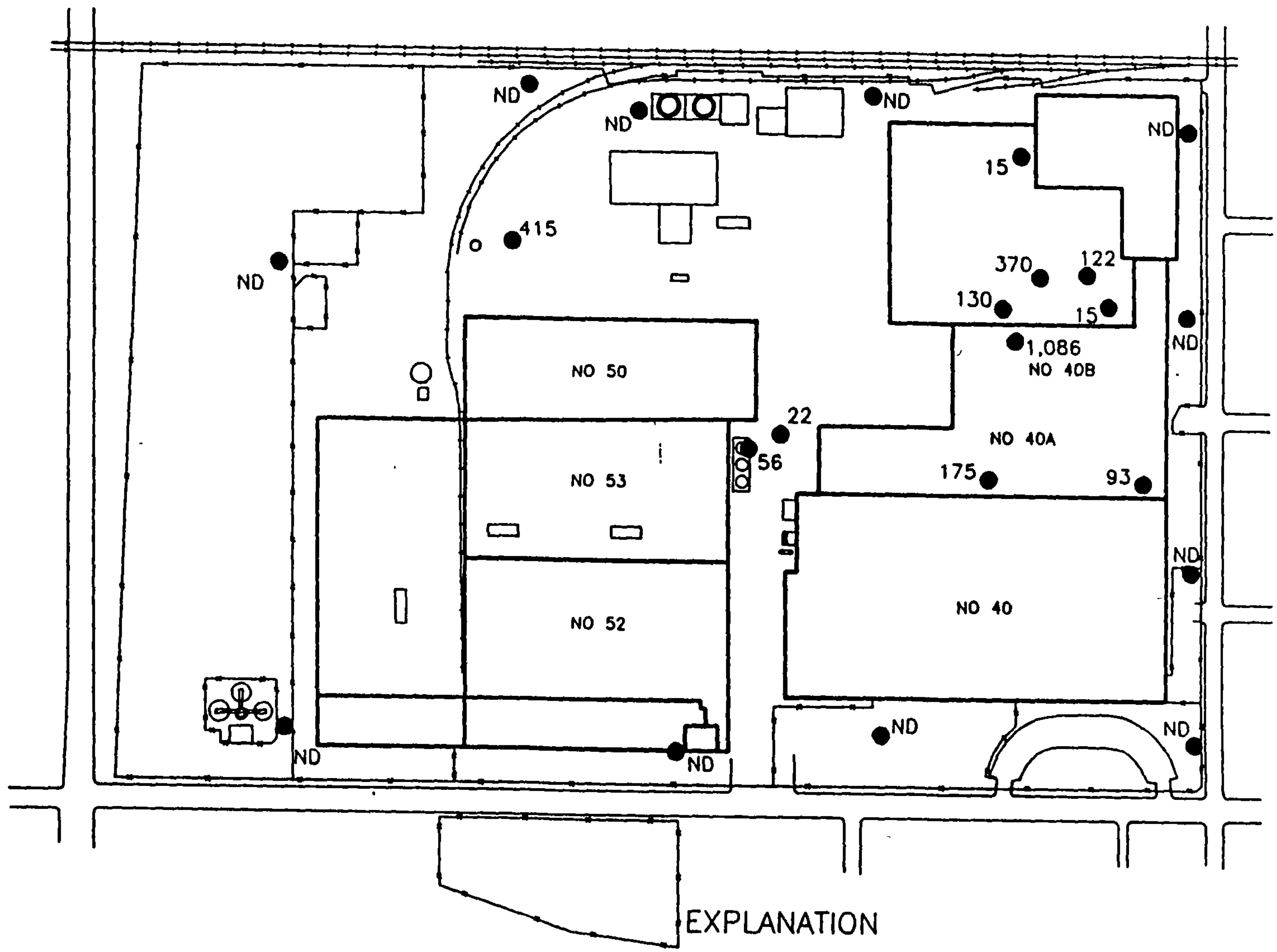

NOTE: Soil gas and groundwater headspace samples were collected from PH-02, and groundwater samples were collected from PH-03.

John Mathes & Associates, Inc.

SAMPLING LOCATIONS

| ACUSTAR<br>DAYTON, OHIO<br>423023 | FIGURE 17 |
|---|---|

| REV. B DATE 5/15/91 | DRAWN BY | TMM 5-17-91 | CHECKED BY | PTS 5/17/91 | DOCUMENT MANAGER | 26 5-20-91 | PROJECT MANAGER | [illegible] 5/20/91 |
|---|---|---|---|---|---|---|---|---|




EXPLANATION

● 1,086 APPROXIMATE SOIL GAS PROBE HOLE LOCATION WITH TRICHLOROETHENE CONCENTRATION IN ug/L (8 – 10 FEET)

NOTE: Soil gas samples from PH-04 were collected at 13.5 to 14.5 feet.

0 300 600
SCALE IN FEET

N

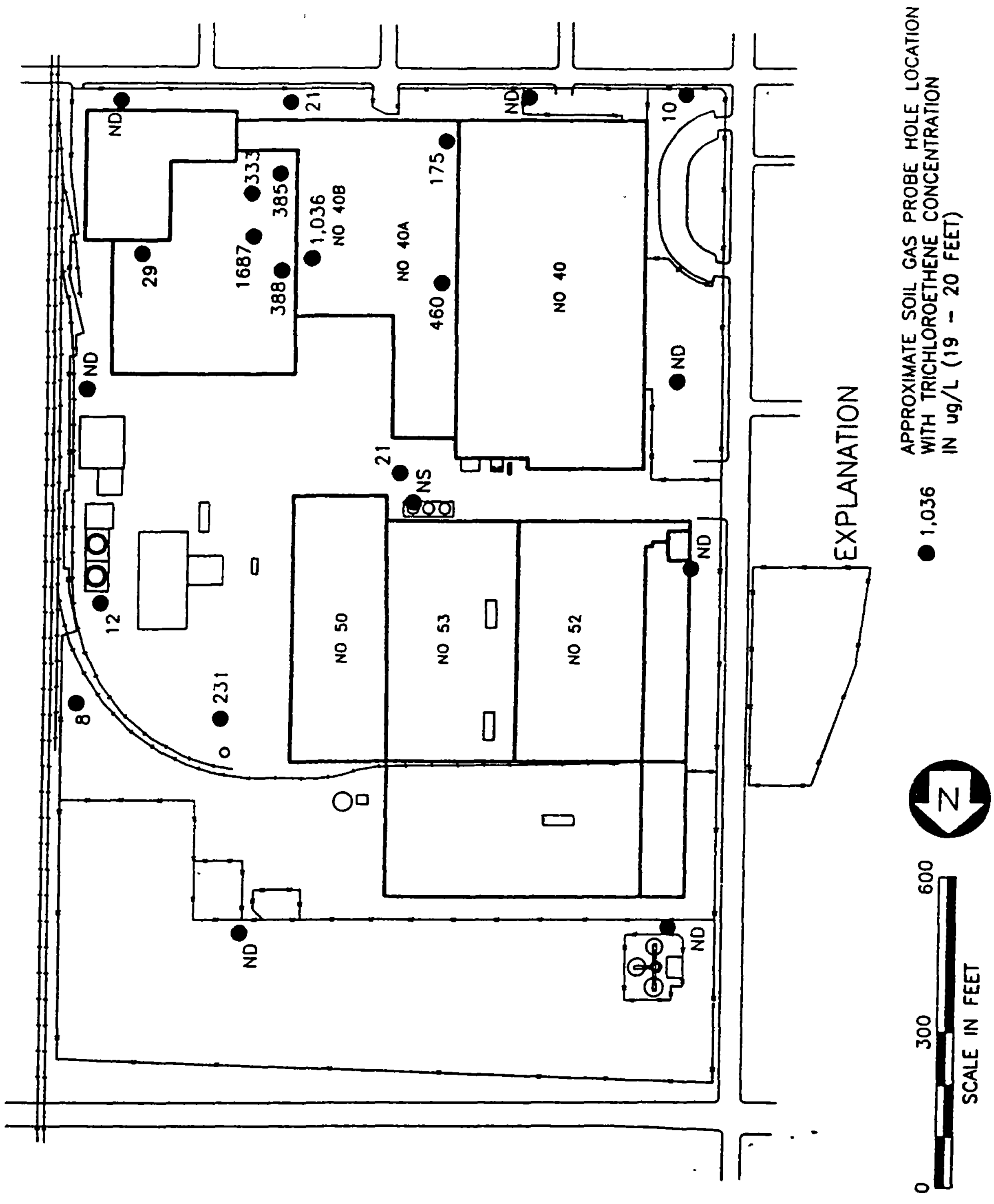
John Mathes & Associates, Inc.

TRICHLOROETHENE CONCENTRATION IN SOIL GAS (RECON SM) AT 8'– 10' (ug/L)

ACUSTAR
DAYTON, OHIO
423023

FIGURE 18

| REV. DATE | DRAWN BY | CHECKED BY | DOCUMENT MANAGER | PROJECT MANAGER |
|---|---|---|---|---|
| B 5/15/91 | TMM 5-17-91 | PTS 5/17/91 | 36 5-20-91 | 5/20/91 |

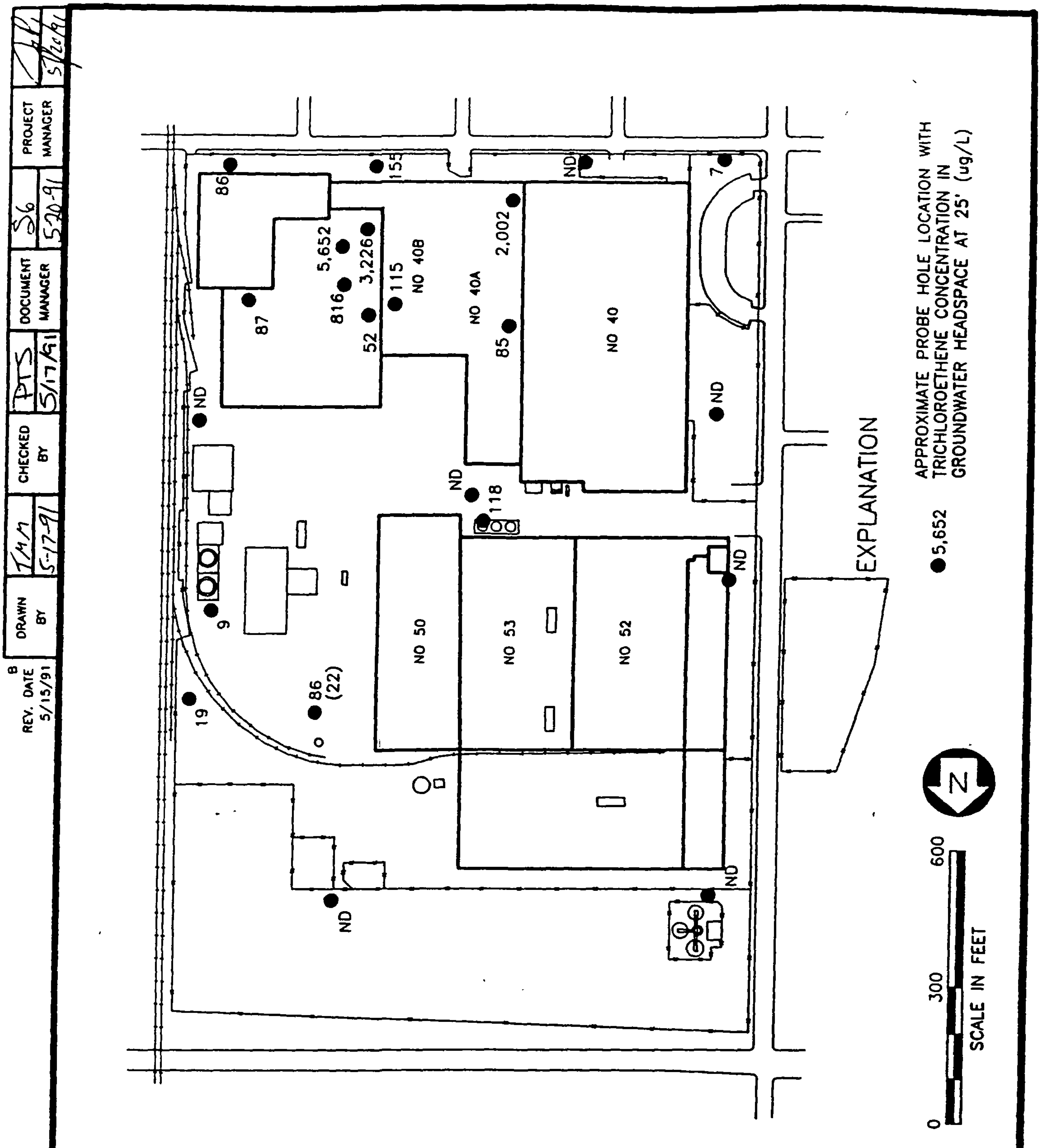



John Mathes & Associates, Inc.

TRICHLOROETHENE
CONCENTRATION IN SOIL GAS
(RECON SM) AT 19'– 20' (ug/L)

ACUSTAR
DAYTON, OHIO
423023

FIGURE 19

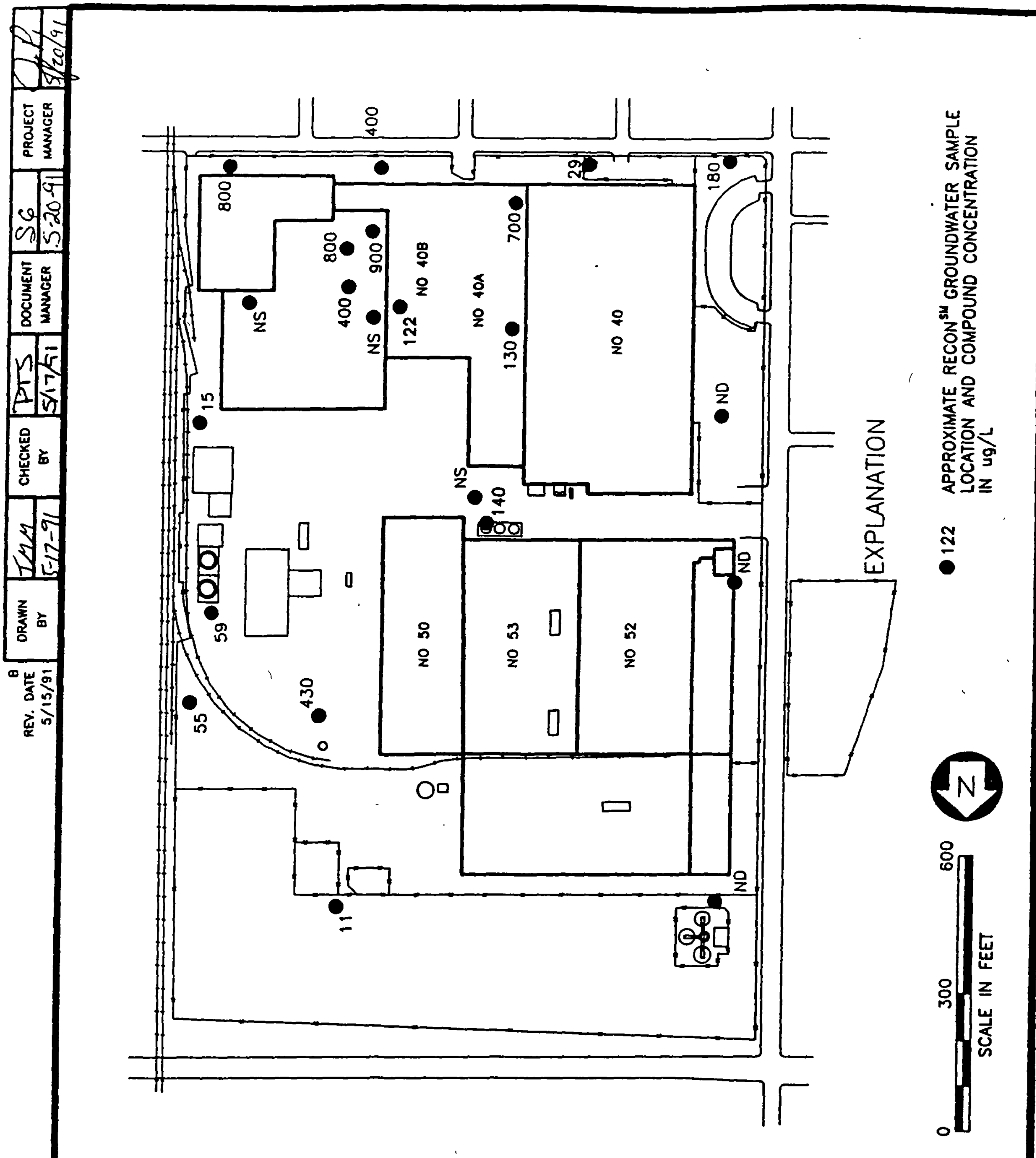



John Mathes & Associates, Inc.

TRICHLOROETHENE CONCENTRATION (ug/L) IN GROUNDWATER HEADSPACE COLLECTED AT 25' USING RECON SM

ACUSTAR
DAYTON, OHIO
423023

FIGURE 20




John Mathes & Associates, Inc.

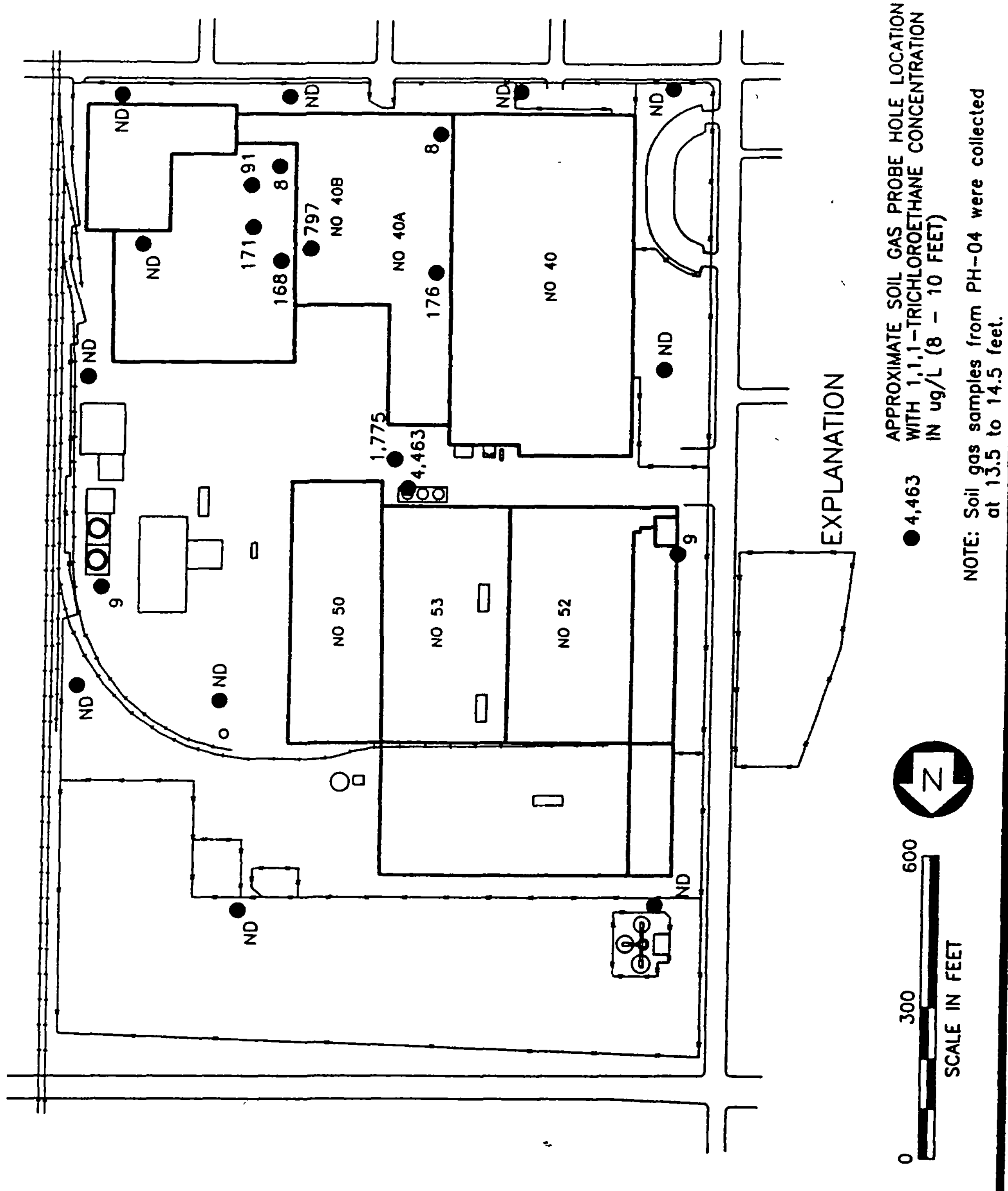
TRICHLOROETHENE CONCENTRATION (ug/L) IN GROUNDWATER

ACUSTAR
DAYTON, OHIO
423023

FIGURE 21

B
REV. DATE 5/15/91

| DRAWN BY | CHECKED BY | DOCUMENT MANAGER | PROJECT MANAGER |
|---|---|---|---|
| TAM 5-17-91 | PTS 5/17/91 | S6 5-20-91 | 5/20/91 |

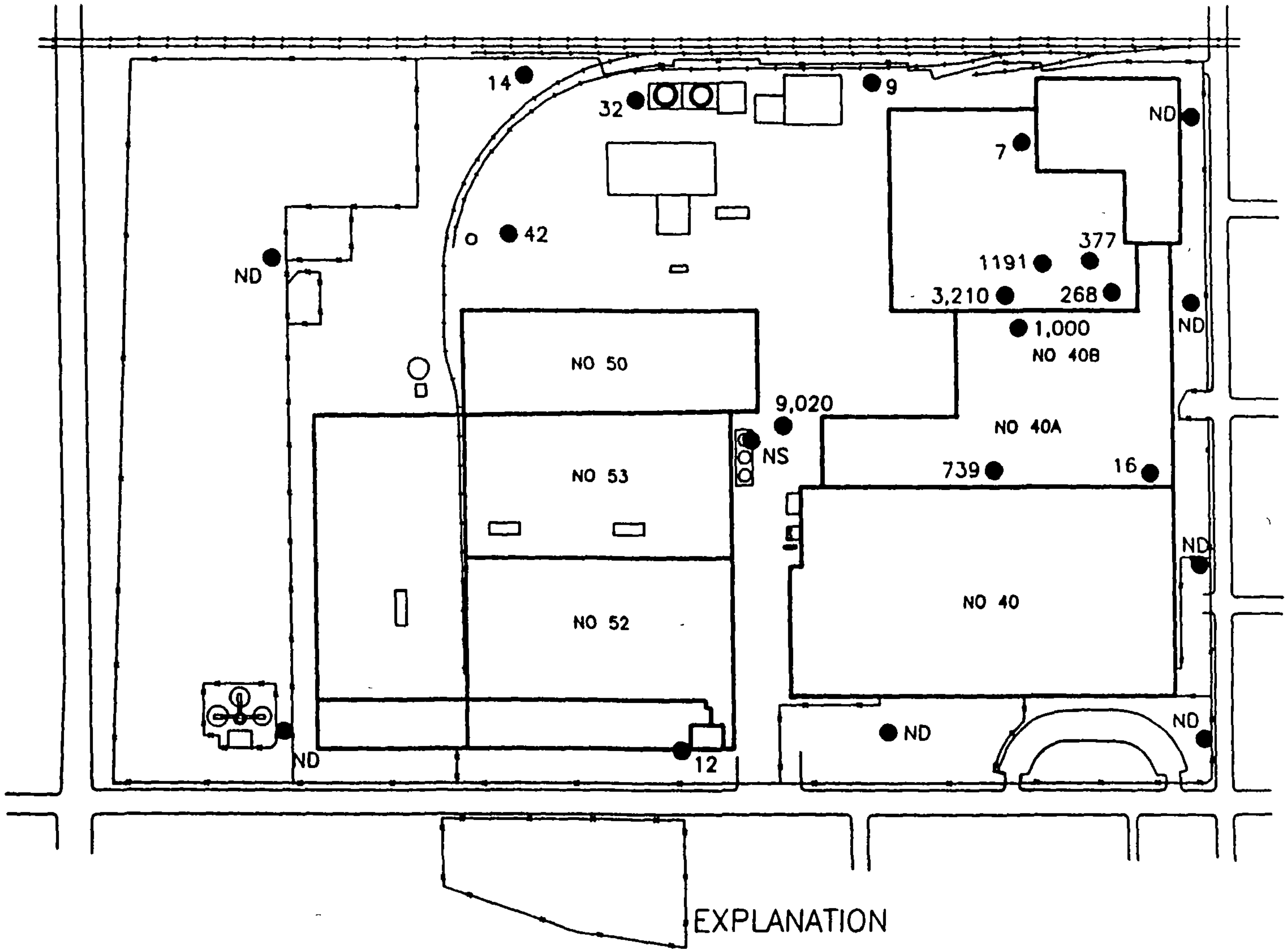


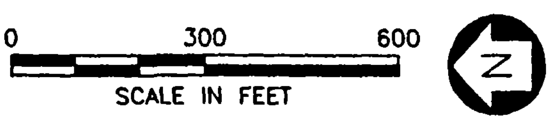

John Mathes & Associates, Inc.

1,1,1-TRICHLOROETHANE CONCENTRATION IN SOIL GAS (RECON SM) AT 8'- 10' (ug/L)

| ACUSTAR DAYTON, OHIO 423023 | FIGURE 22 |
|---|---|

| REV. 1 | DRAWN BY | | CHECKED BY | | DOCUMENT MANAGER | | PROJECT MANAGER | |
|---|---|---|---|---|---|---|---|---|
| 5/15/91 | | 5-17-91 | | 5/17/91 | | 5-20-91 | | 5/20/91 |




EXPLANATION

● 739 APPROXIMATE SOIL GAS PROBE HOLE LOCATION WITH 1,1,1-TRICHLOROETHANE CONCENTRATION IN ug/L (19 - 20 FEET)

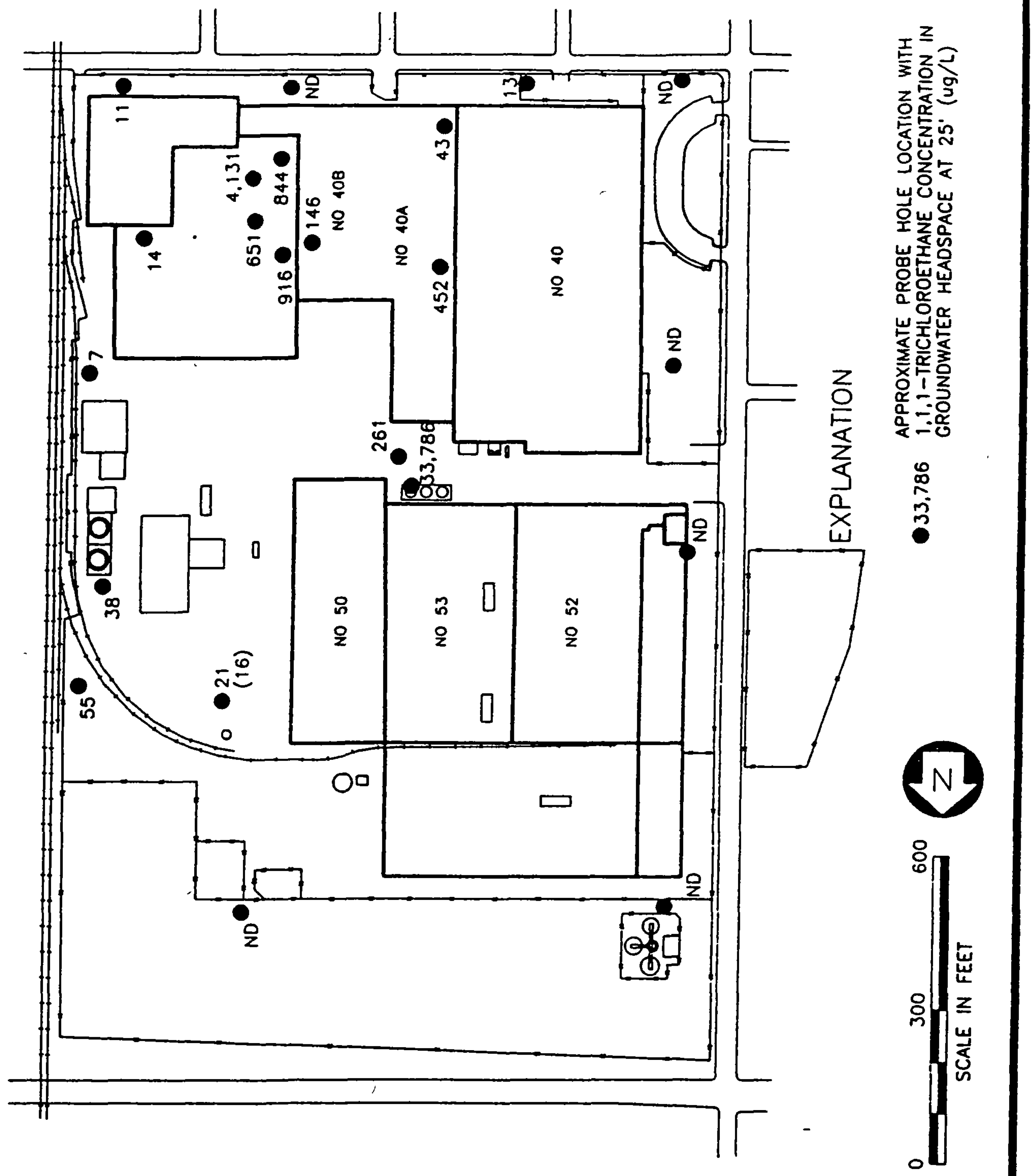
John Mathes & Associates, Inc.

1,1,1-TRICHLOROETHANE CONCENTRATION IN SOIL GAS (RECON SM) AT 19'- 20' (ug/L)

ACUSTAR
DAYTON, OHIO

FIGURE 23

| REV. | DATE | DRAWN BY | CHECKED BY | DOCUMENT MANAGER | PROJECT MANAGER |
|---|---|---|---|---|---|
| B | 5/15/91 | TAA 5-17-91 | PTS 5/17/91 | SG 5-20-91 | 5/20/91 |

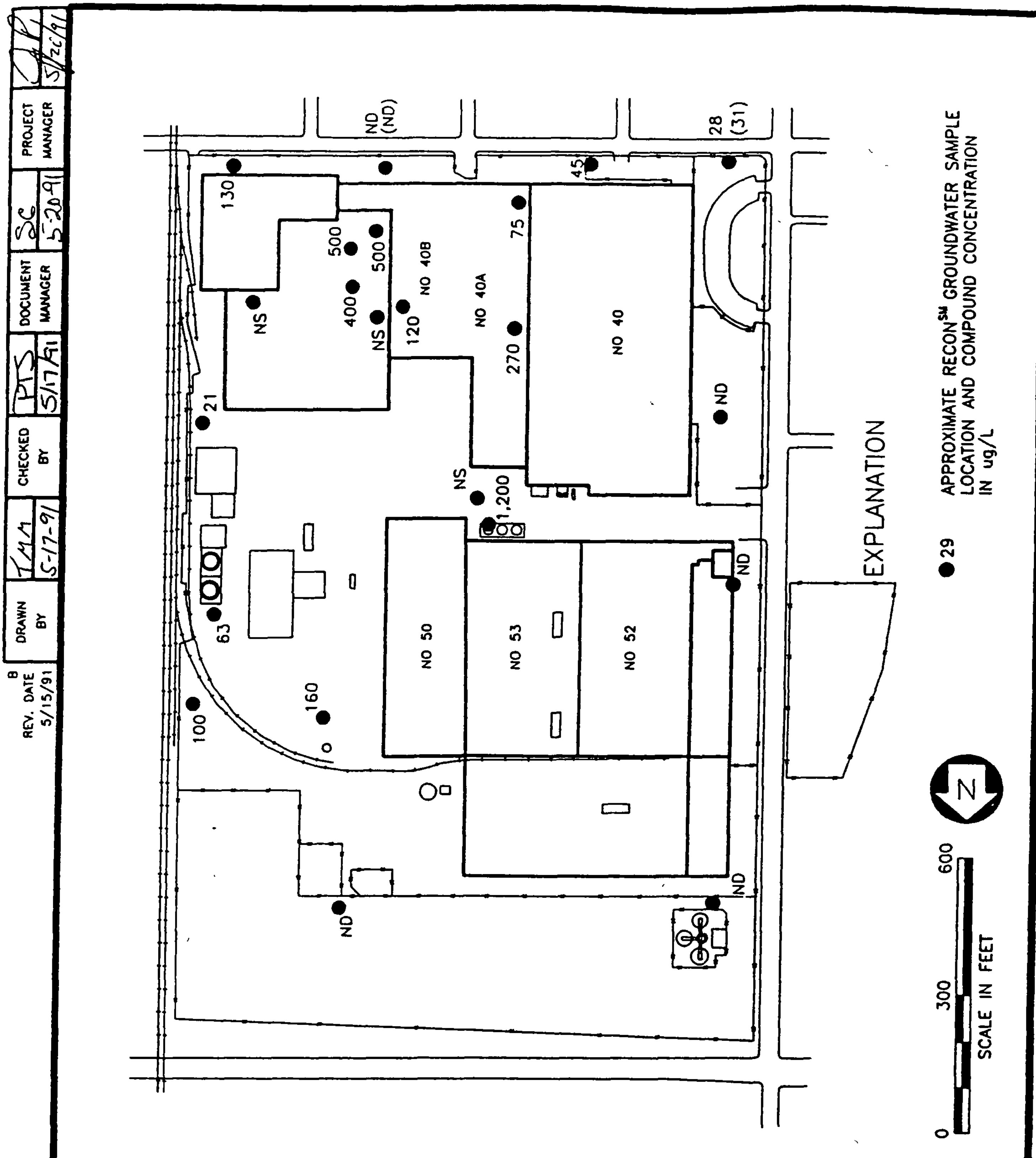



John Mathes & Associates, Inc.

1,1,1-TRICHLOROETHANE CONCENTRATION (ug/L) IN GROUNDWATER HEADSPACE COLLECTED AT 25' USING RECON℠

ACUSTAR
DAYTON, OHIO
423023

FIGURE 24

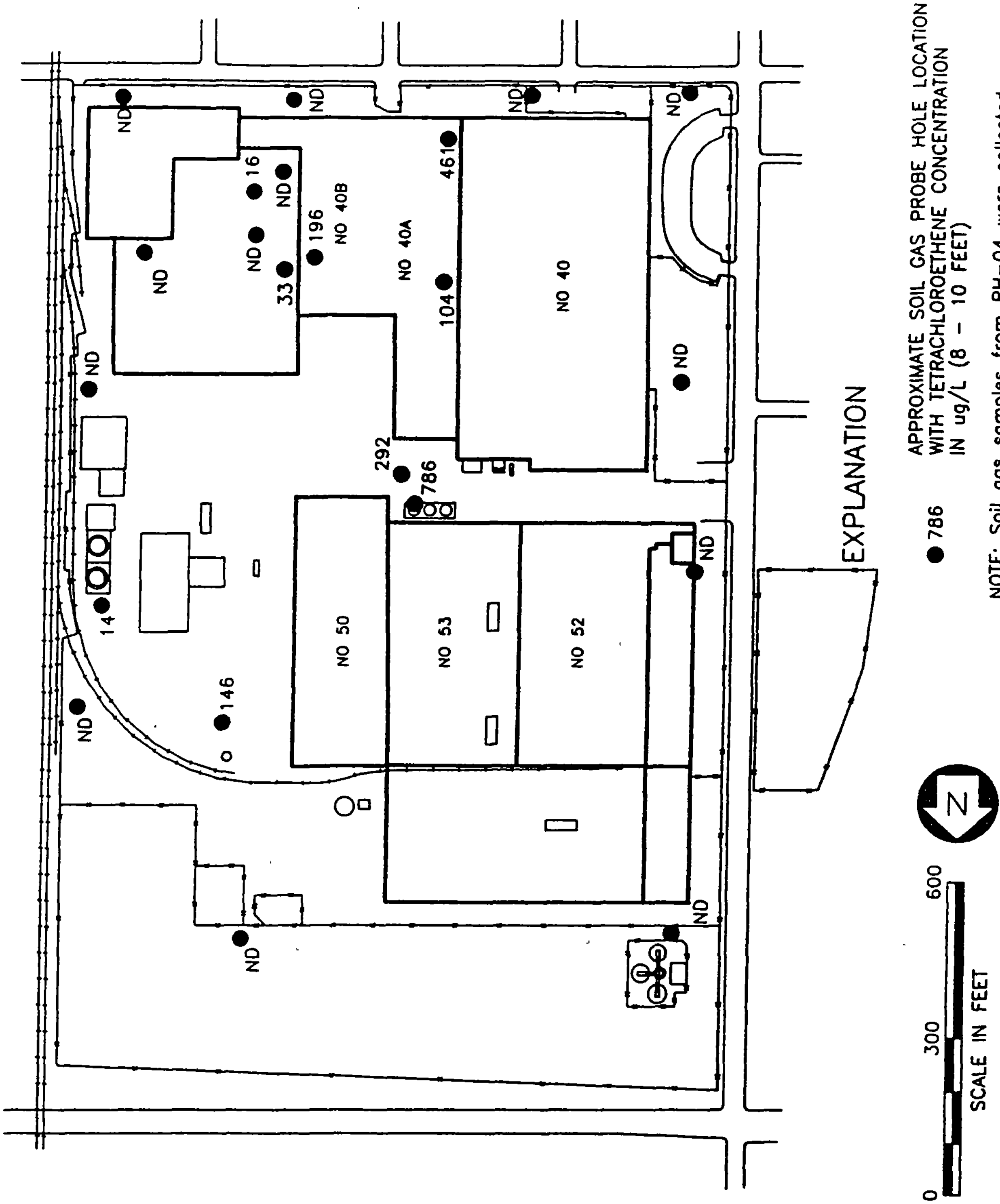



John Mathes & Associates, Inc.

1,1,1-TRICHLOROETHANE
CONCENTRATION (ug/L)
IN GROUNDWATER

| | |
|---|---|
| ACUSTAR<br>DAYTON, OHIO<br>423023 | FIGURE 25 |

| REV. DATE | DRAWN BY | CHECKED BY | DOCUMENT MANAGER | PROJECT MANAGER |
|---|---|---|---|---|
| B 5/15/91 | 5-17-91 | PTS 5/17/91 | 5-20-91 | 5/20/91 |




EXPLANATION

● 786 APPROXIMATE SOIL GAS PROBE HOLE LOCATION WITH TETRACHLOROETHENE CONCENTRATION IN ug/L (8 - 10 FEET)

NOTE: Soil gas samples from PH-04 were collected at 13.5 to 14.5 feet.

0 300 600
SCALE IN FEET

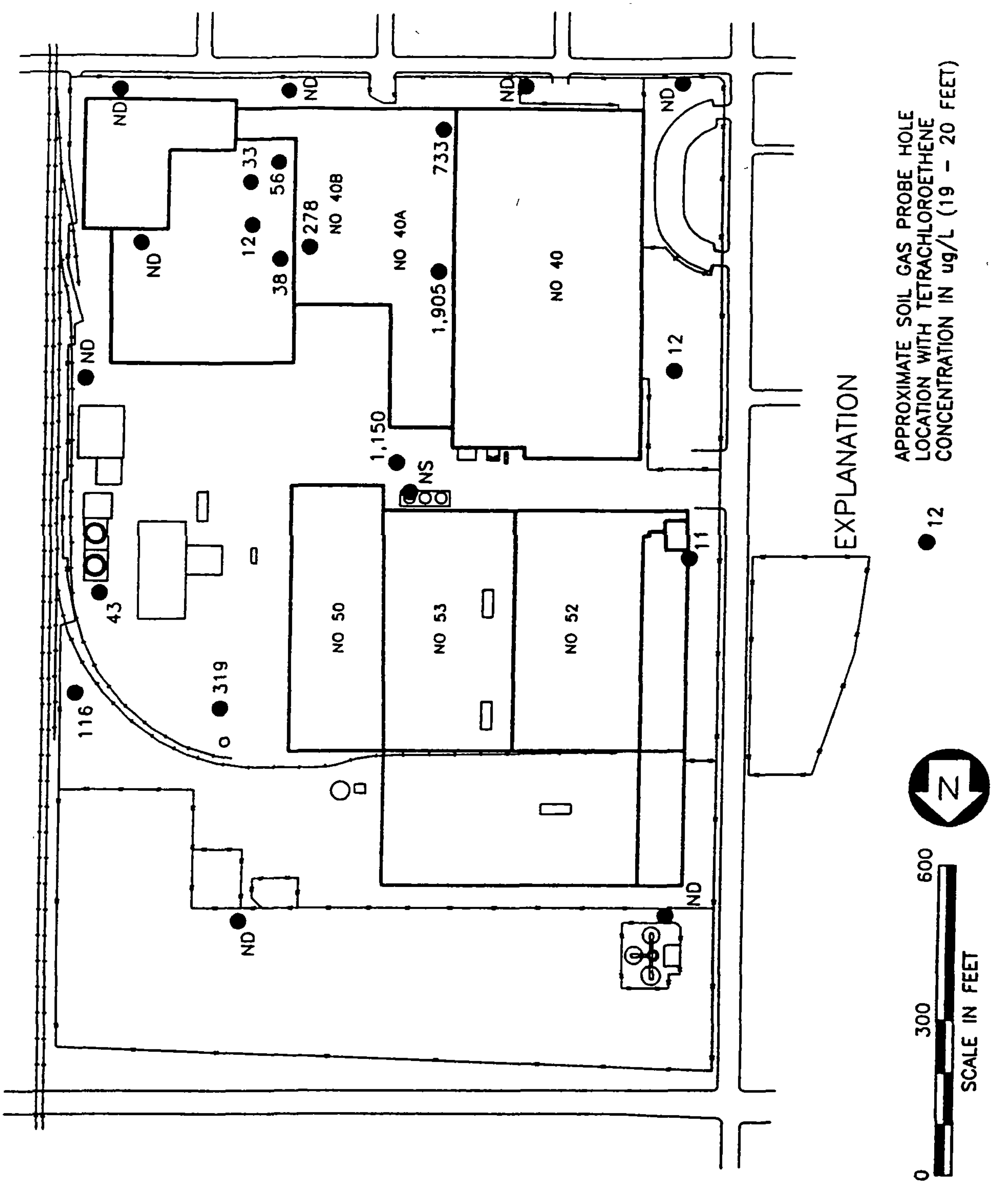
John Mathes & Associates, Inc.

TETRACHLOROETHENE CONCENTRATION IN SOIL GAS (RECON SM) AT 8'- 10' (ug/L)

ACUSTAR
DAYTON, OHIO
423023

FIGURE 26

| REV. DATE | DRAWN BY | CHECKED BY | DOCUMENT MANAGER | PROJECT MANAGER |
|---|---|---|---|---|
| B 5/15/91 | TMM 5-17-91 | PTS 5/17/91 | JG 5-20-91 | 5/20/91 |

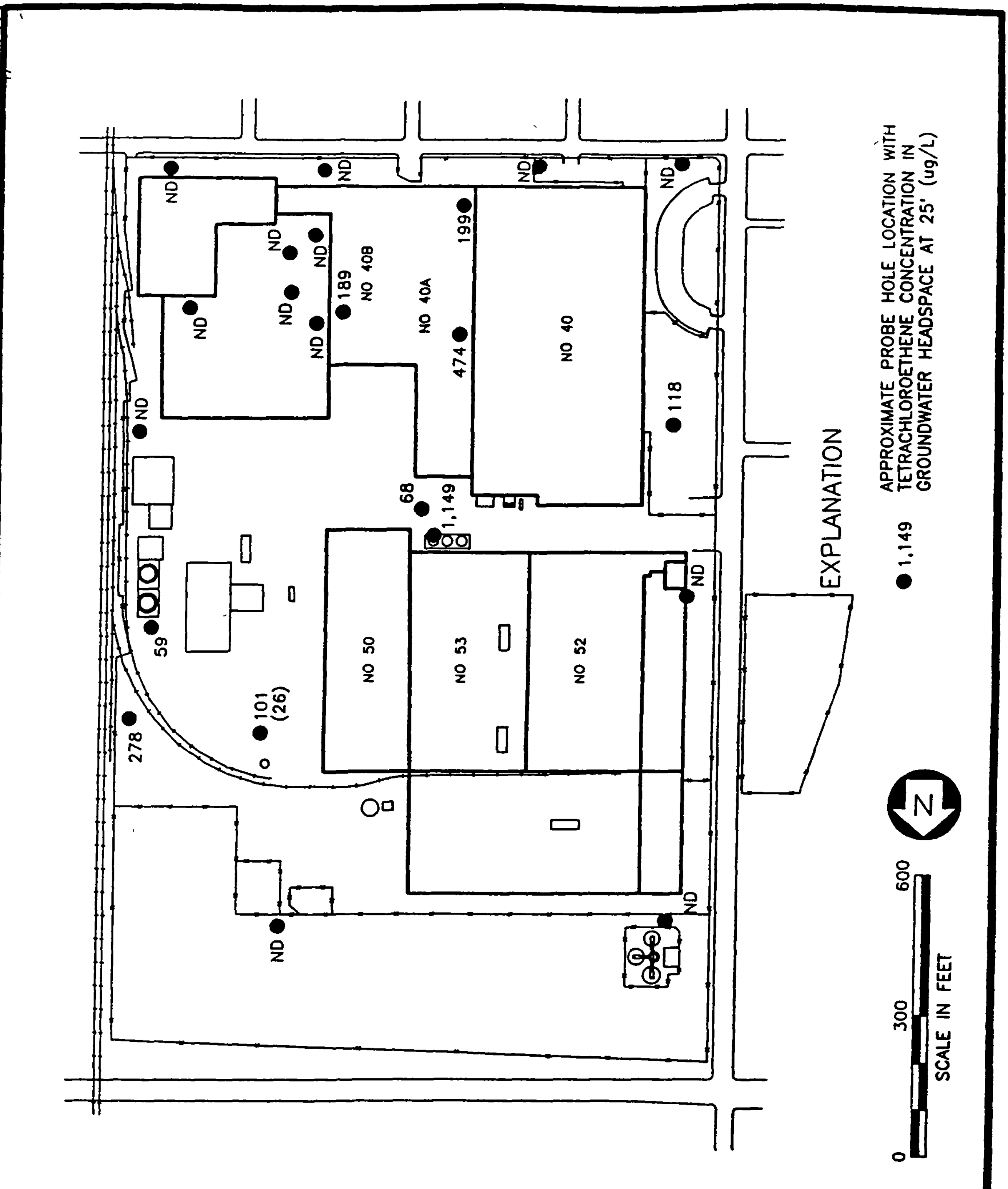



John Mathes & Associates, Inc.

TETRACHLOROETHENE CONCENTRATION IN SOIL GAS (RECON$^{SM}$) AT 19'– 20' (ug/L)

ACUSTAR
DAYTON, OHIO
423023

FIGURE 27



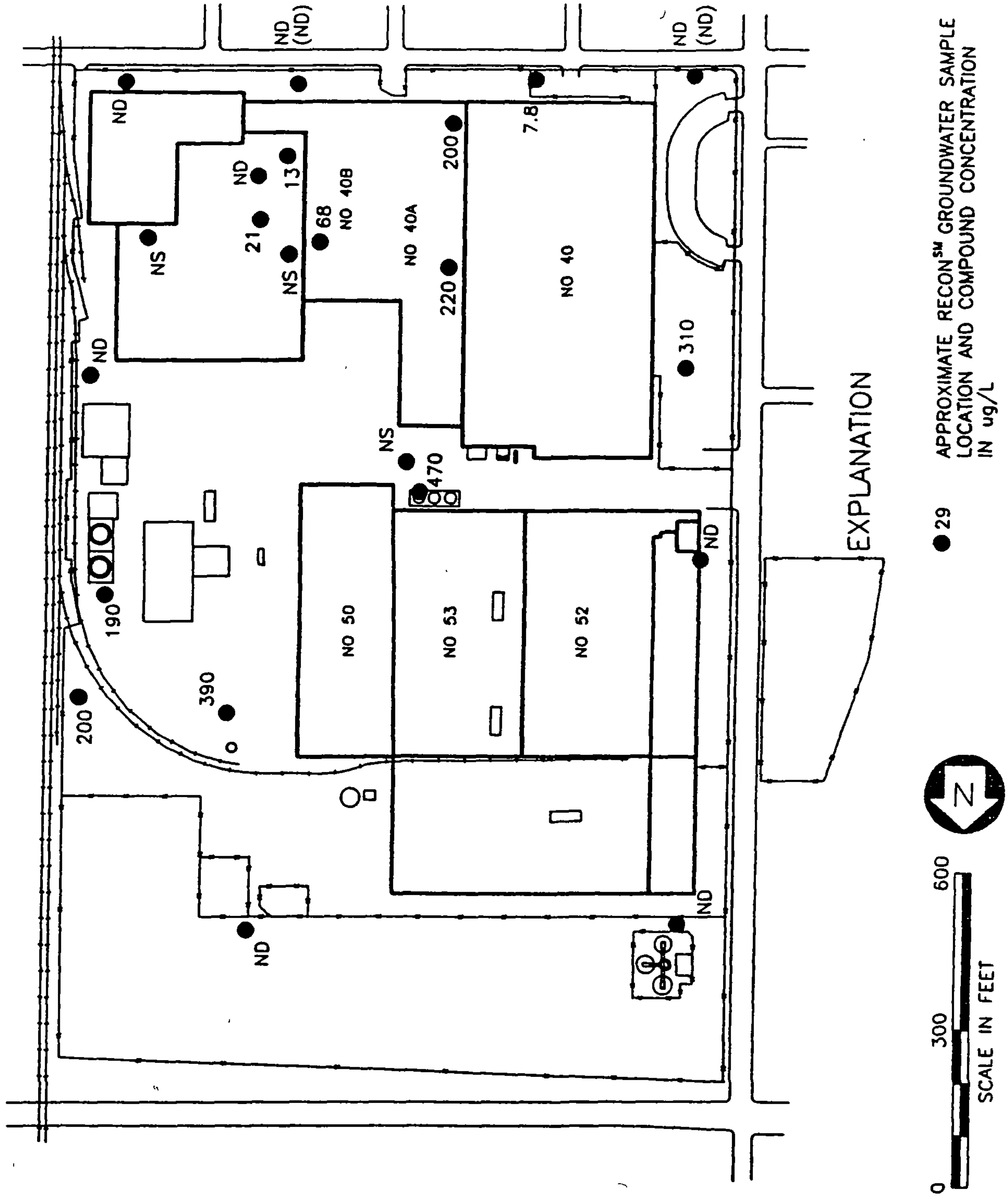

| REV. | DATE | DRAWN BY | CHECKED BY | DOCUMENT MANAGER | PROJECT MANAGER |
|---|---|---|---|---|---|
| B | 5/15/91 | TMM 5-17-91 | PTS 5/17/91 | SG 5-20-91 | 5/20/91 |

John Mathes & Associates, Inc.

TETRACHLOROETHENE CONCENTRATION (ug/L) IN GROUNDWATER HEADSPACE COLLECTED AT 25' USING RECON℠

| | |
|---|---|
| ACUSTAR<br>DAYTON, OHIO<br>423023 | FIGURE 28 |

| REV. | DATE | DRAWN BY | CHECKED BY | DOCUMENT MANAGER | PROJECT MANAGER |
|---|---|---|---|---|---|
| B | 5/15/91 | TAM 5-17-91 | PTS 5/17/91 | SG 5-20-91 | 5/20/91 |

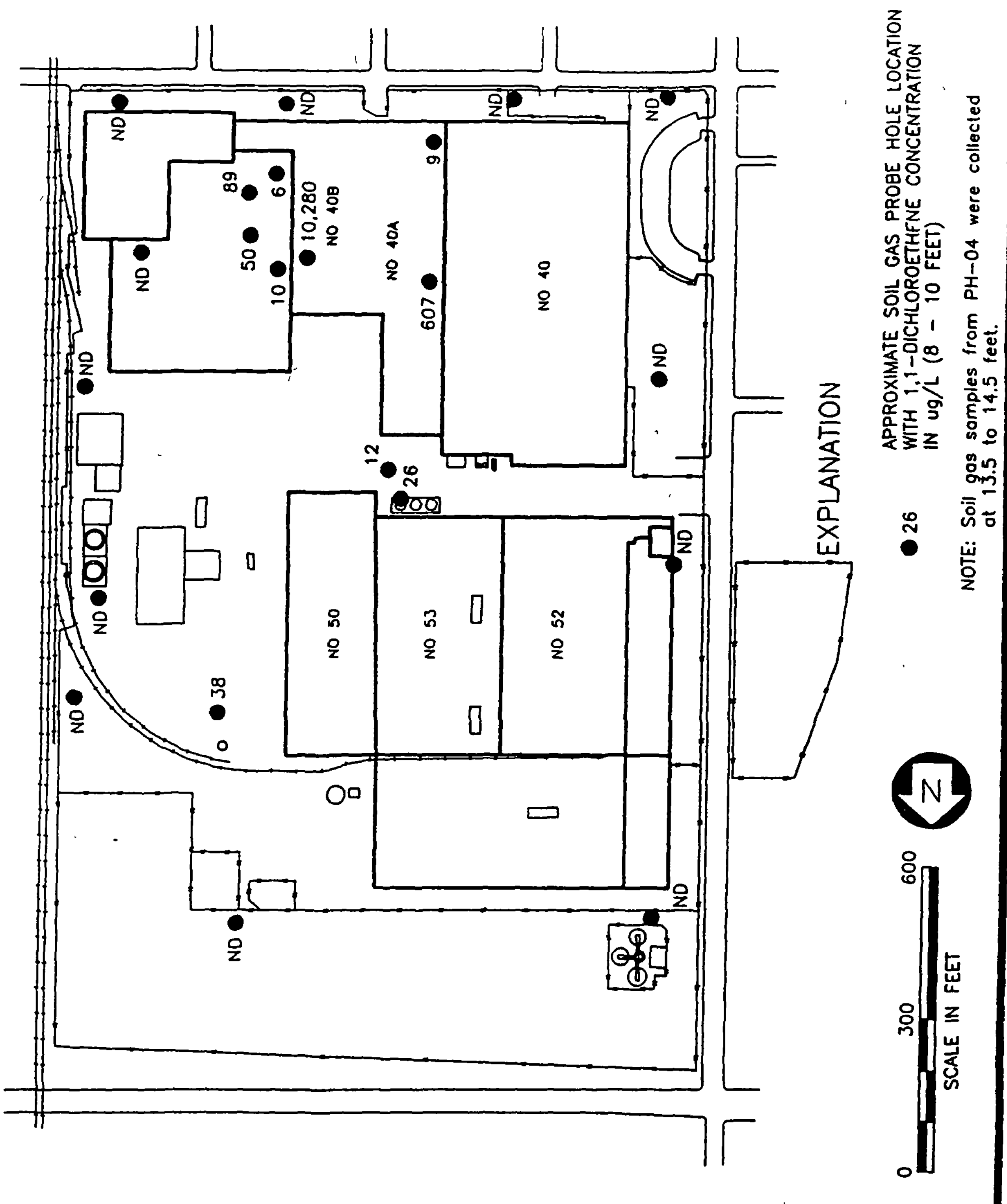



John Mathes & Associates, Inc.

TETRACHLOROETHENE CONCENTRATION (ug/L) IN GROUNDWATER

ACUSTAR
DAYTON, OHIO
423023

FIGURE 29



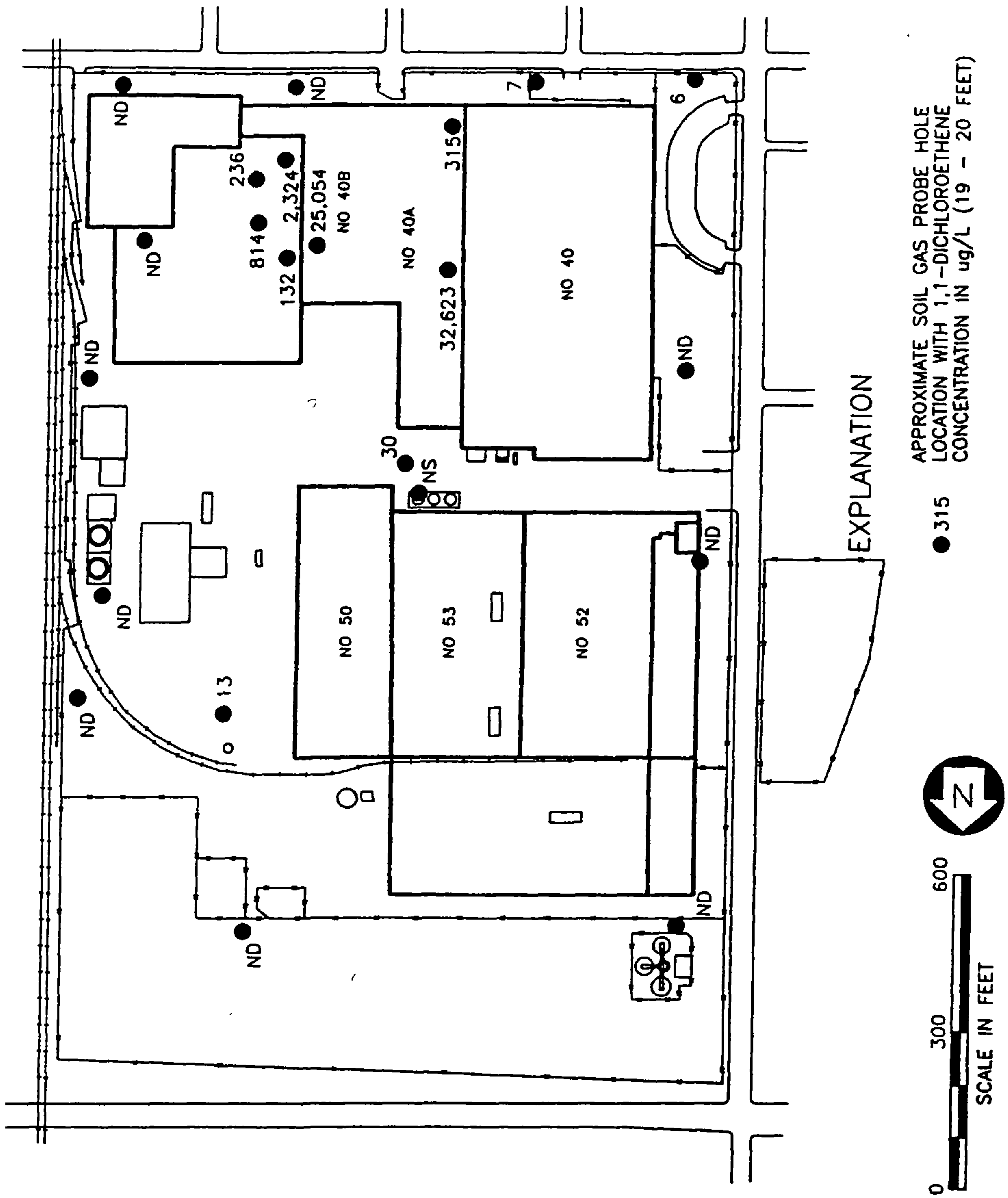

| PROJECT MANAGER | DOCUMENT MANAGER | CHECKED BY | DRAWN BY | REV. DATE |
|---|---|---|---|---|
| 5/20/91 | 5-20-91 | 5/17/91 | 5-17-91 | B 5/15/91 |

John Mathes & Associates, Inc.

1,1-DICHLOROETHENE CONCENTRATION IN SOIL GAS (RECON SM) AT 8'- 10' (ug/L)

ACUSTAR
DAYTON, OHIO
423023

FIGURE 30



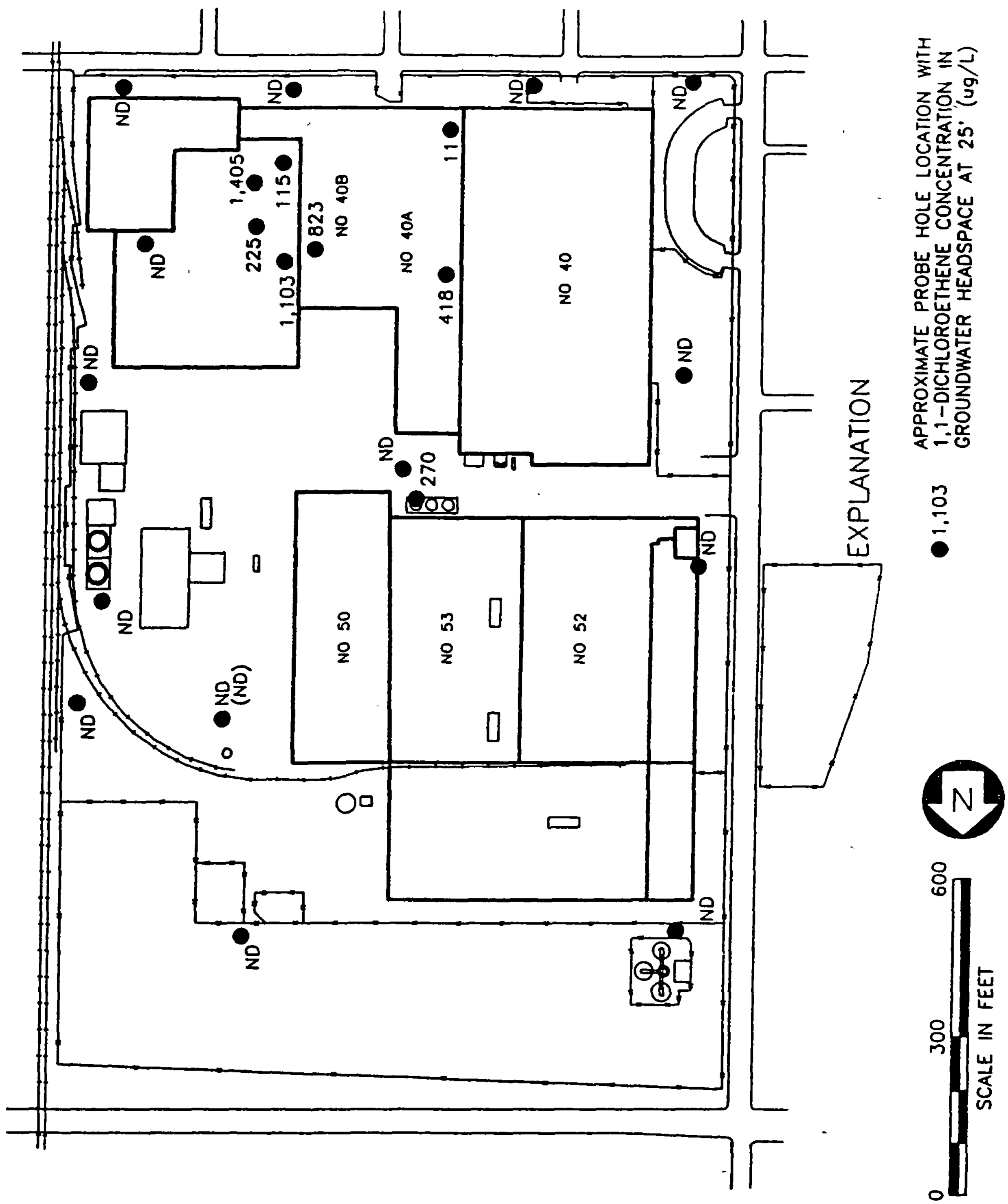

REV. B DATE 5/15/91 | DRAWN BY TAM 5-17-91 | CHECKED BY PTS 5/17/91 | DOCUMENT MANAGER SG 5-20-91 | PROJECT MANAGER 5/20/91

John Mathes & Associates, Inc.

1,1 DICHLOROETHENE CONCENTRATION IN SOIL GAS (RECON$^{SM}$) AT 19'– 20' (ug/L)

ACUSTAR
DAYTON, OHIO
423023

FIGURE 31




| REV. | DATE | DRAWN BY | CHECKED BY | DOCUMENT MANAGER | PROJECT MANAGER |
|---|---|---|---|---|---|
| B | 5/15/91 | TMM 5-17-91 | PTS 5/17/91 | SG 5-20-91 | 5/20/91 |

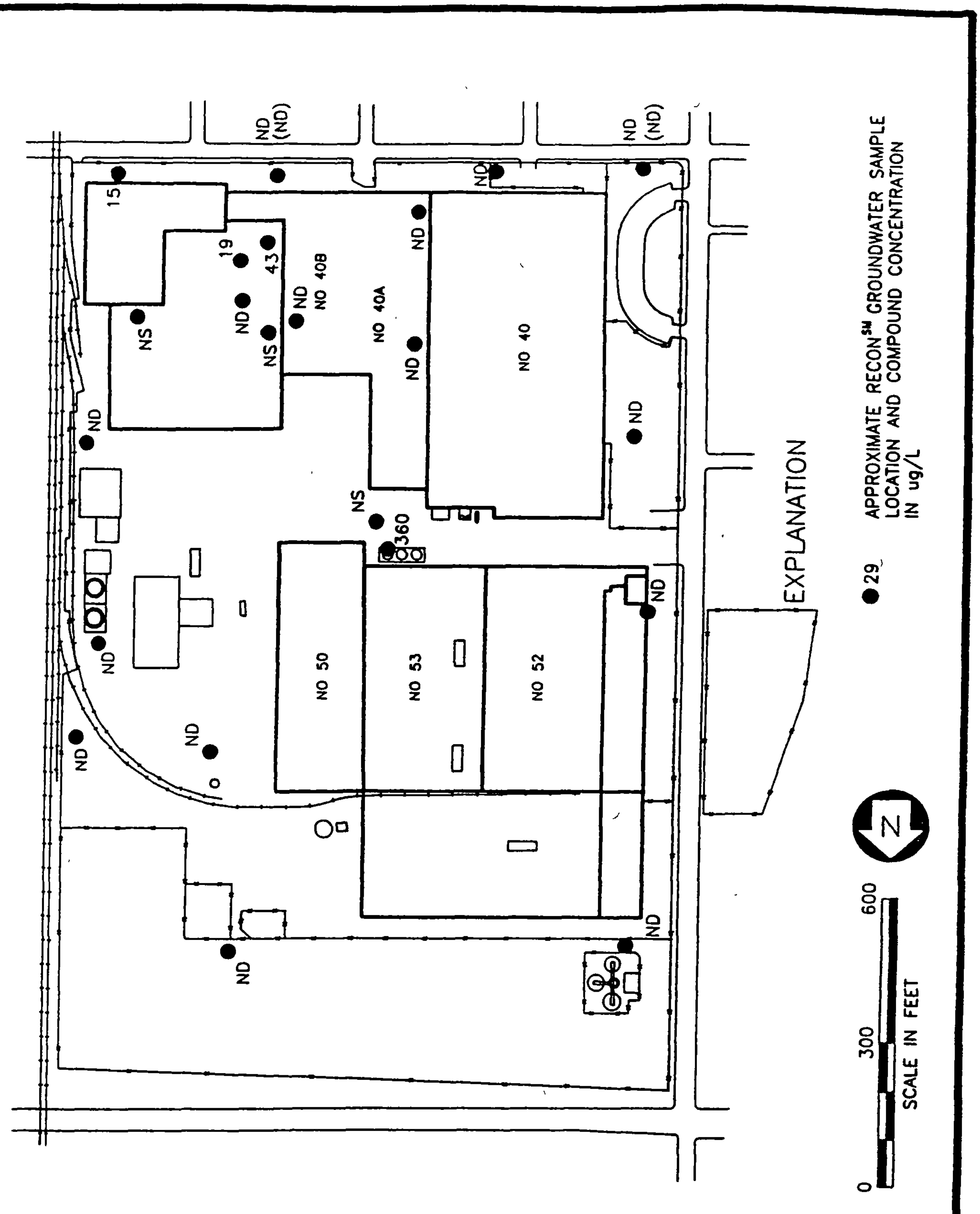
John Mathes & Associates, Inc.

1,1-DICHLOROETHENE CONCENTRATION (ug/L) IN GROUNDWATER HEADSPACE COLLECTED AT 25' USING RECON℠

ACUSTAR
DAYTON, OHIO
423023

FIGURE 32

REV. DATE B 5/15/91 | DRAWN BY TMM 5-17-91 | CHECKED BY DJS 5/17/91 | DOCUMENT MANAGER 5-20-91 | PROJECT MANAGER 5/20/91




John Mathes & Associates, Inc.

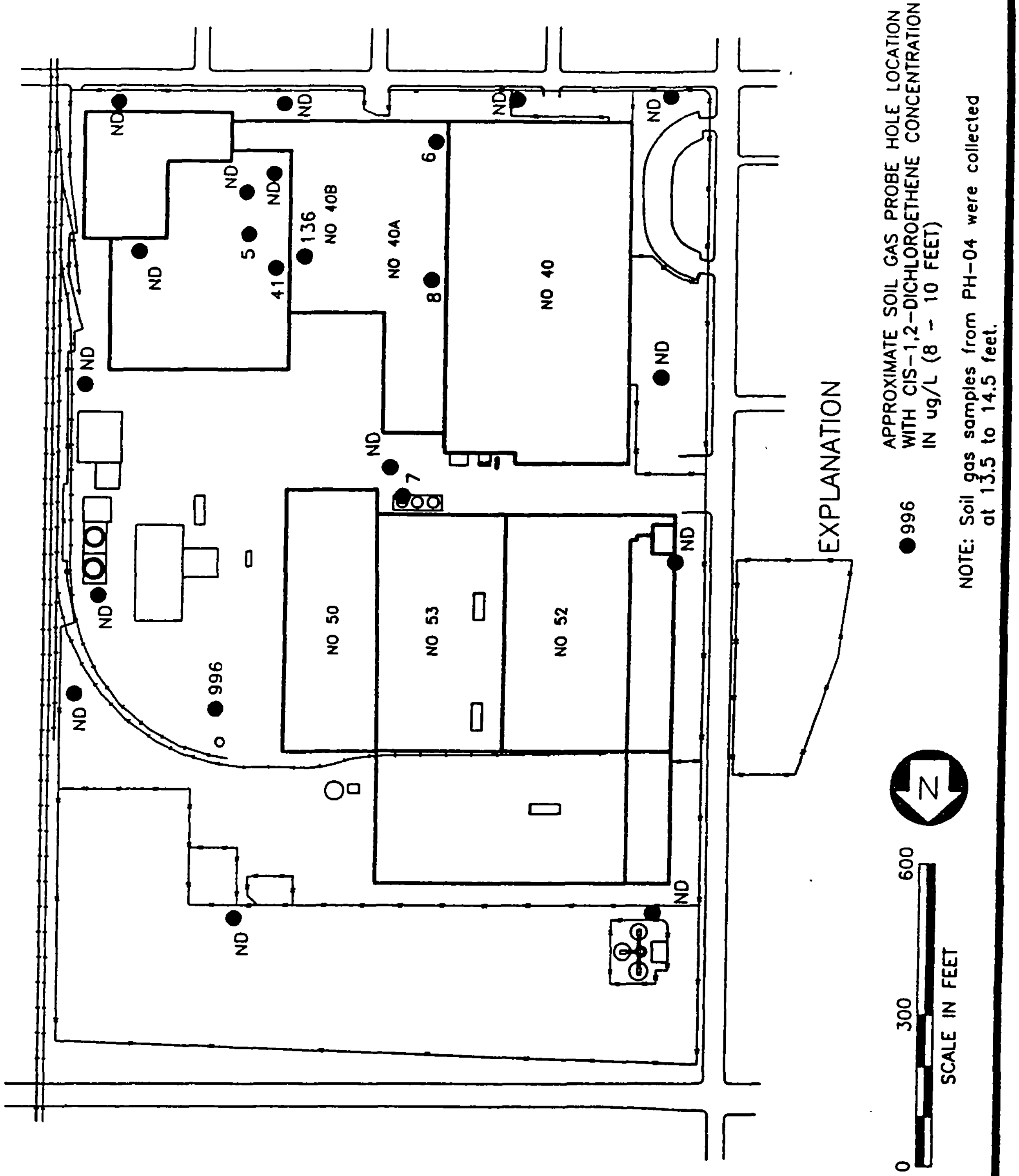
1,1-DICHLOROETHENE CONCENTRATION (ug/L) IN GROUNDWATER

ACUSTAR
DAYTON, OHIO
423023

FIGURE 33

| DRAWN BY | CHECKED BY | DOCUMENT MANAGER | PROJECT MANAGER |
|---|---|---|---|
| TMM 5-17-91 | PTS 5/17/91 | SG 5-20-91 | 5/20/91 |

REV. DATE 5/15/91 td



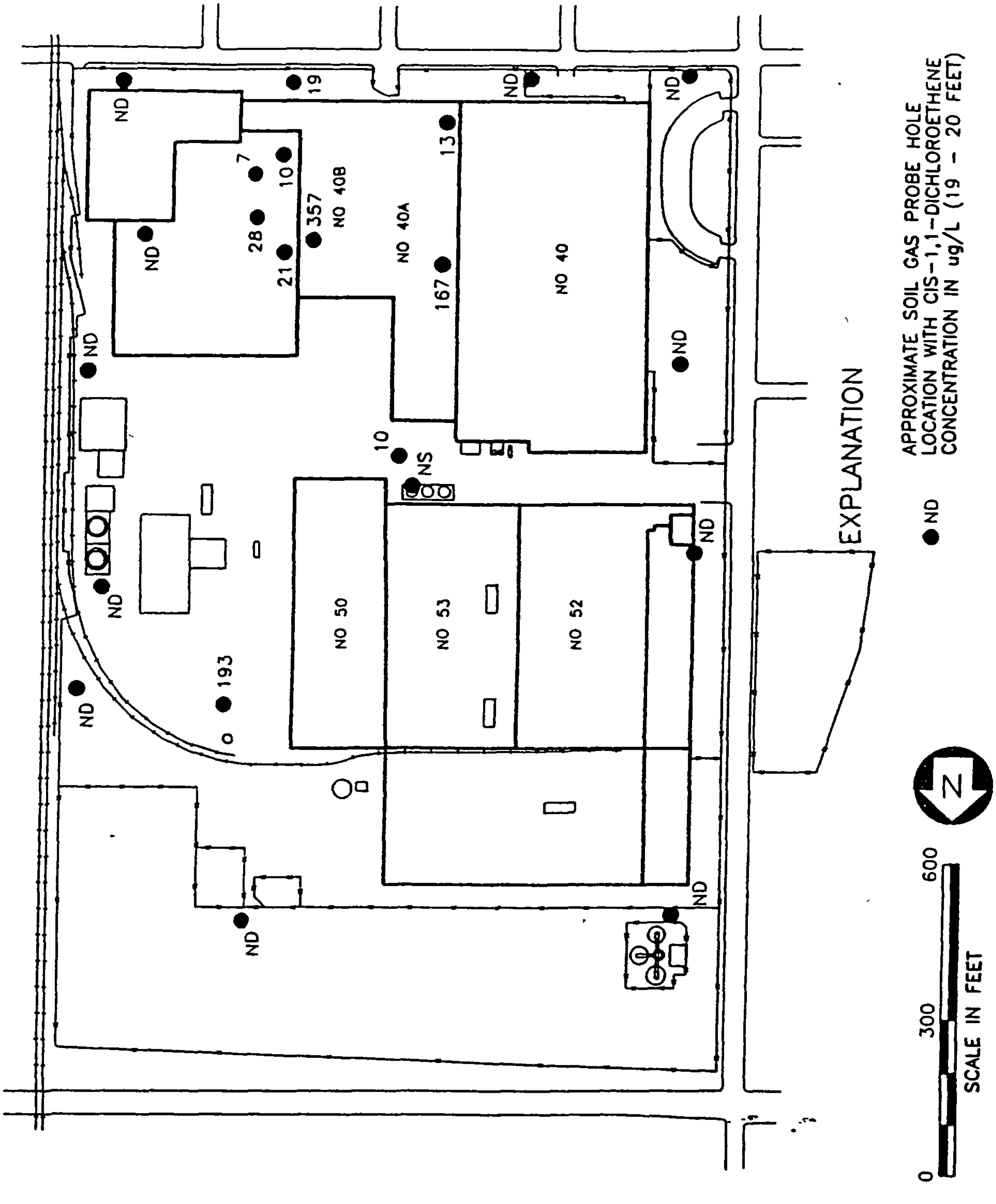

John Mathes & Associates, Inc.

CIS-1,2-DICHLOROETHENE CONCENTRATION IN SOIL GAS (RECON SM) AT 8'- 10' (ug/L)

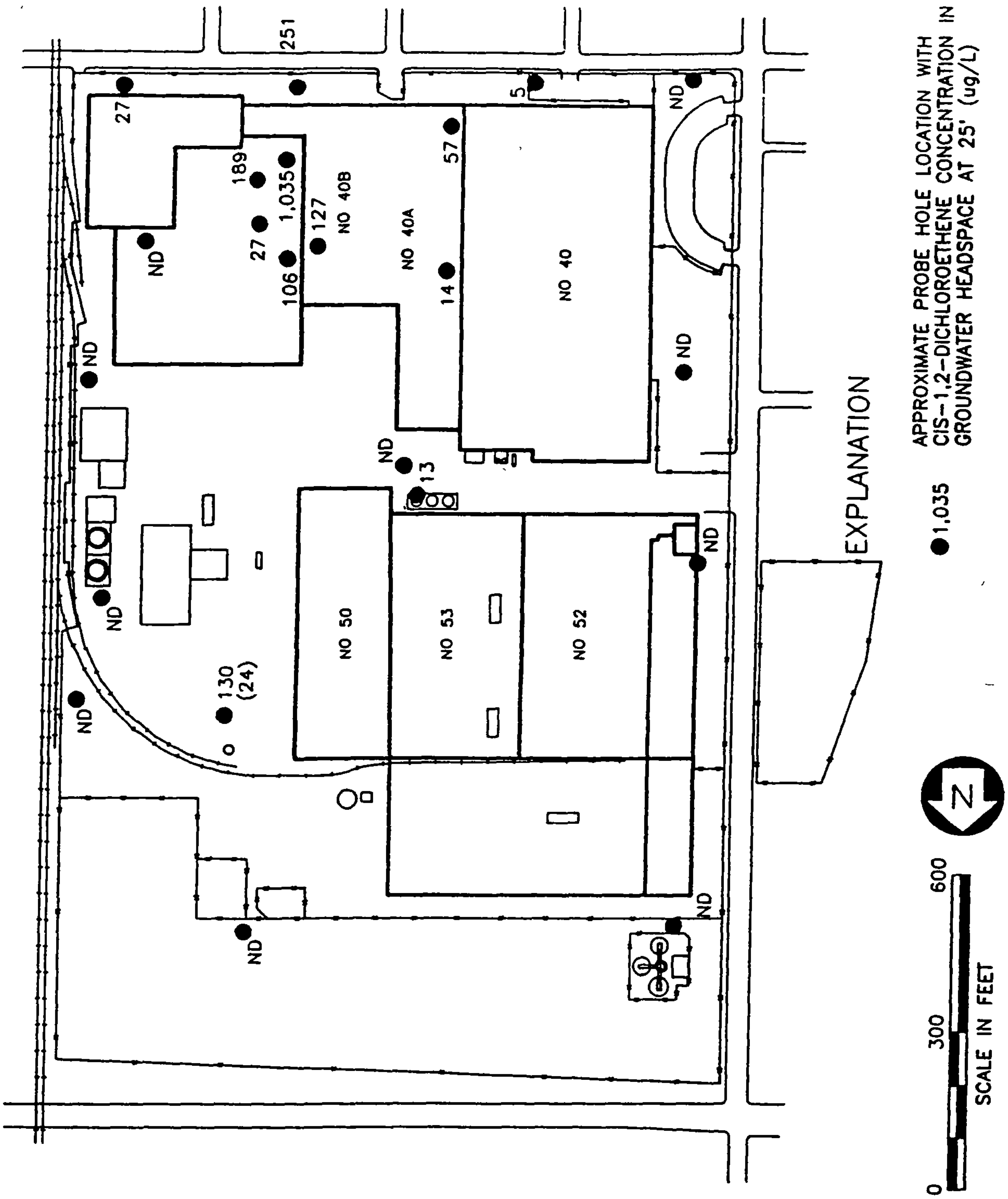
ACUSTAR
DAYTON, OHIO
423023

FIGURE 34

| REV. | DATE | DRAWN BY | CHECKED BY | DOCUMENT MANAGER | PROJECT MANAGER |
|---|---|---|---|---|---|
| B | 5/15/91 | TMA 5-17-91 | PTS 5/17/91 | 36 5-20-91 | 5/20/91 |




| John Mathes & Associates, Inc. | |
|---|---|
| CIS−1,2−DICHLOROETHENE CONCENTRATION IN SOIL GAS (RECON$^{SM}$) AT 19'− 20' (ug/L) | |
| ACUSTAR<br>DAYTON, OHIO<br>423023 | FIGURE 35 |




| DRAWN BY | CHECKED BY | DOCUMENT MANAGER | PROJECT MANAGER |
|---|---|---|---|
| TMM 5-17-91 | PTS 5/17/91 | SG 5-20-91 | 5/20/91 |

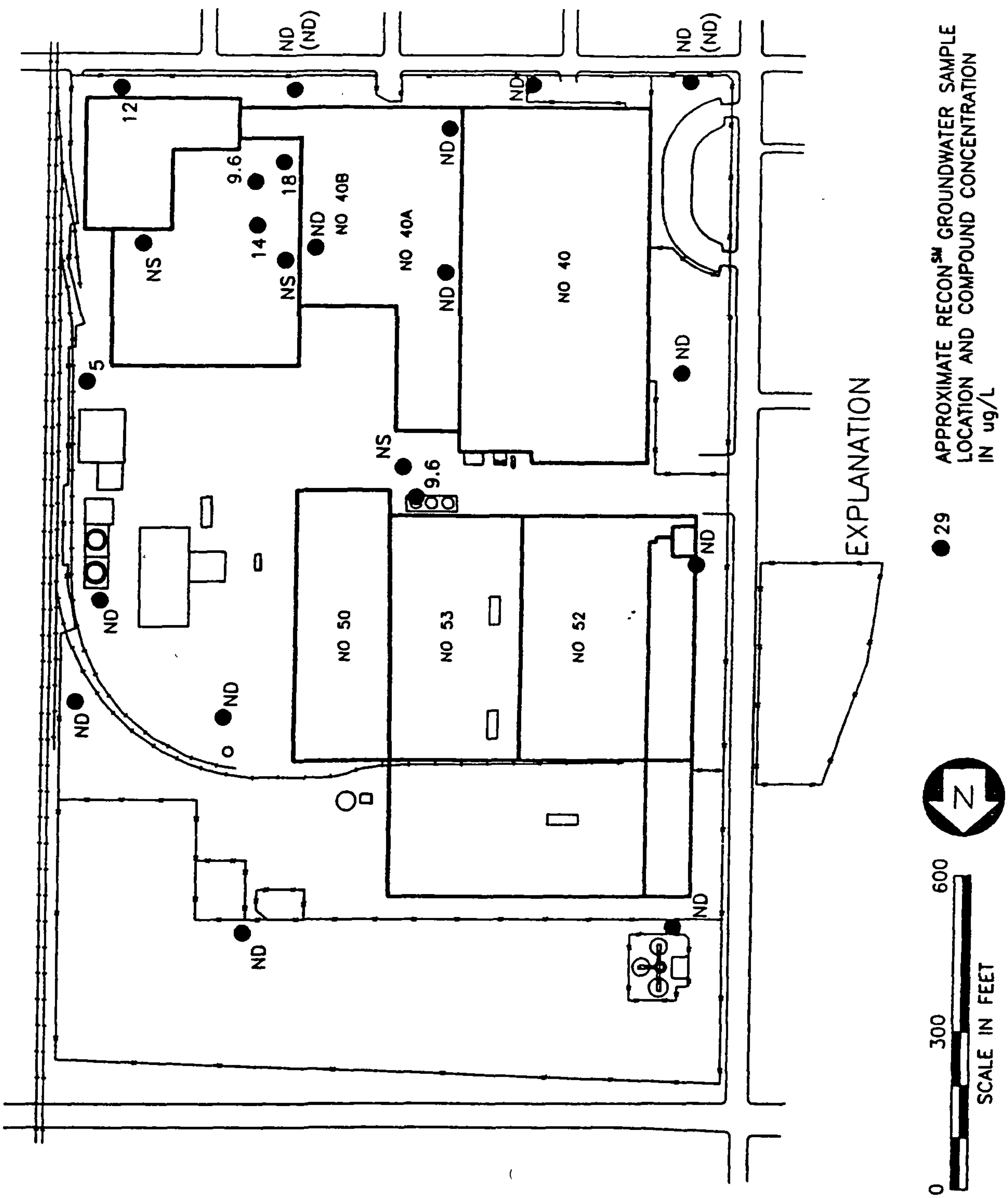
REV. B DATE 5/15/91

John Mathes & Associates, Inc.

CIS-1,2-DICHLOROETHENE CONCENTRATION (ug/L) IN GROUNDWATER HEADSPACE COLLECTED AT 25' USING RECON℠

ACUSTAR
DAYTON, OHIO
423023

FIGURE 36




| DRAWN BY | CHECKED BY | DOCUMENT MANAGER | PROJECT MANAGER |
|---|---|---|---|
| 5-17-91 | 5/17/91 | 5-20-91 | 5/20/91 |

REV. DATE 5/15/91 B

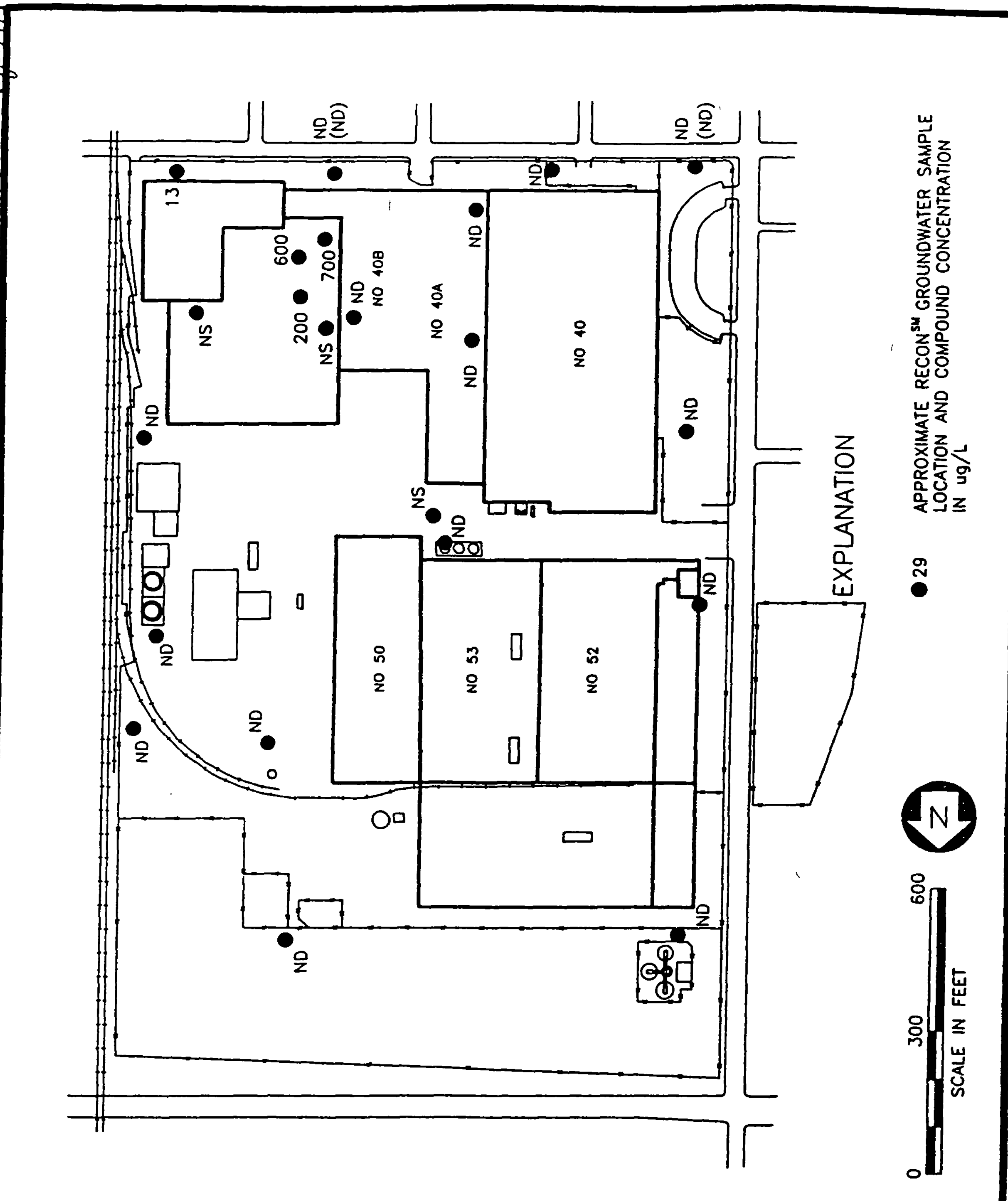
John Mathes & Associates, Inc.

1,1,2-TRICHLOROETHANE CONCENTRATION (ug/L) IN GROUNDWATER

ACUSTAR
DAYTON, OHIO
423023

FIGURE 37

| REV. | DATE | DRAWN BY | CHECKED BY | DOCUMENT MANAGER | PROJECT MANAGER |
|---|---|---|---|---|---|
| B | 5/15/91 | 5-17-91 | PTS 5/17/91 | SG 5-20-91 | 5/20/91 |

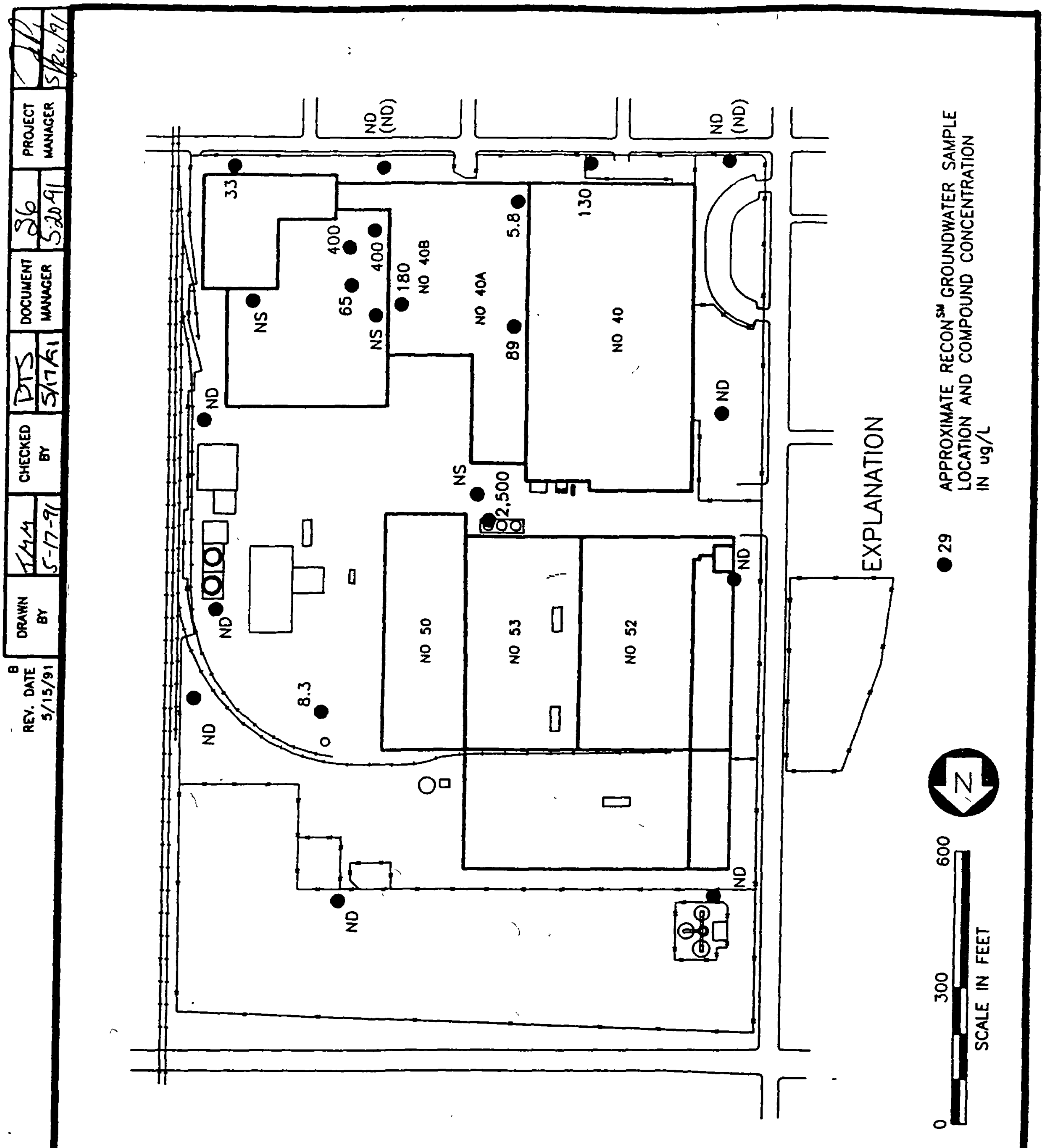



John Mathes & Associates, Inc.

TRANS-1,2-DICHLOROETHENE CONCENTRATION (ug/L) IN GROUNDWATER

ACUSTAR
DAYTON, OHIO
423023

FIGURE 38

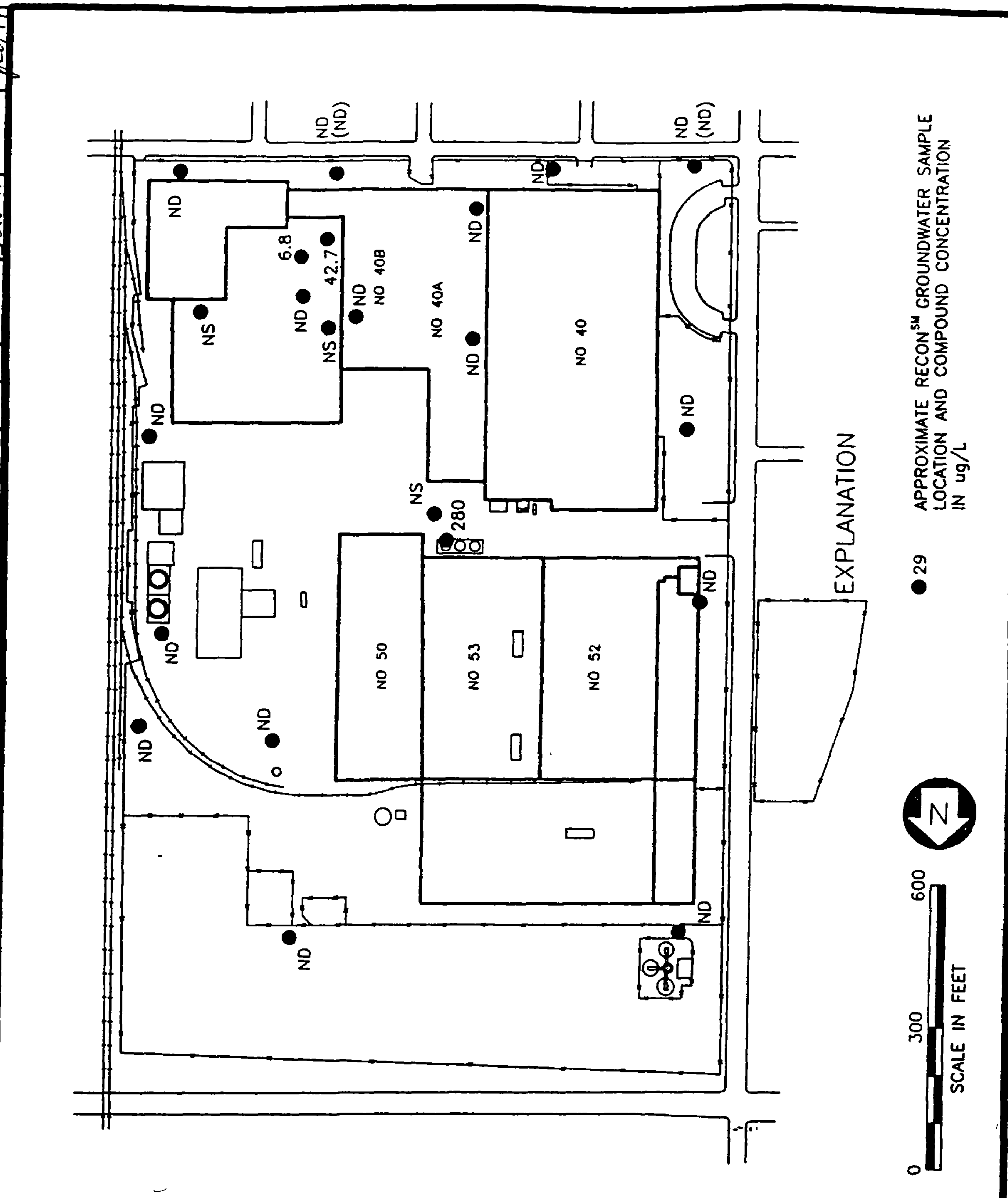



John Mathes & Associates, Inc.

1,1-DICHLOROETHANE CONCENTRATION (ug/L) IN GROUNDWATER

ACUSTAR
DAYTON, OHIO
423023

FIGURE 39



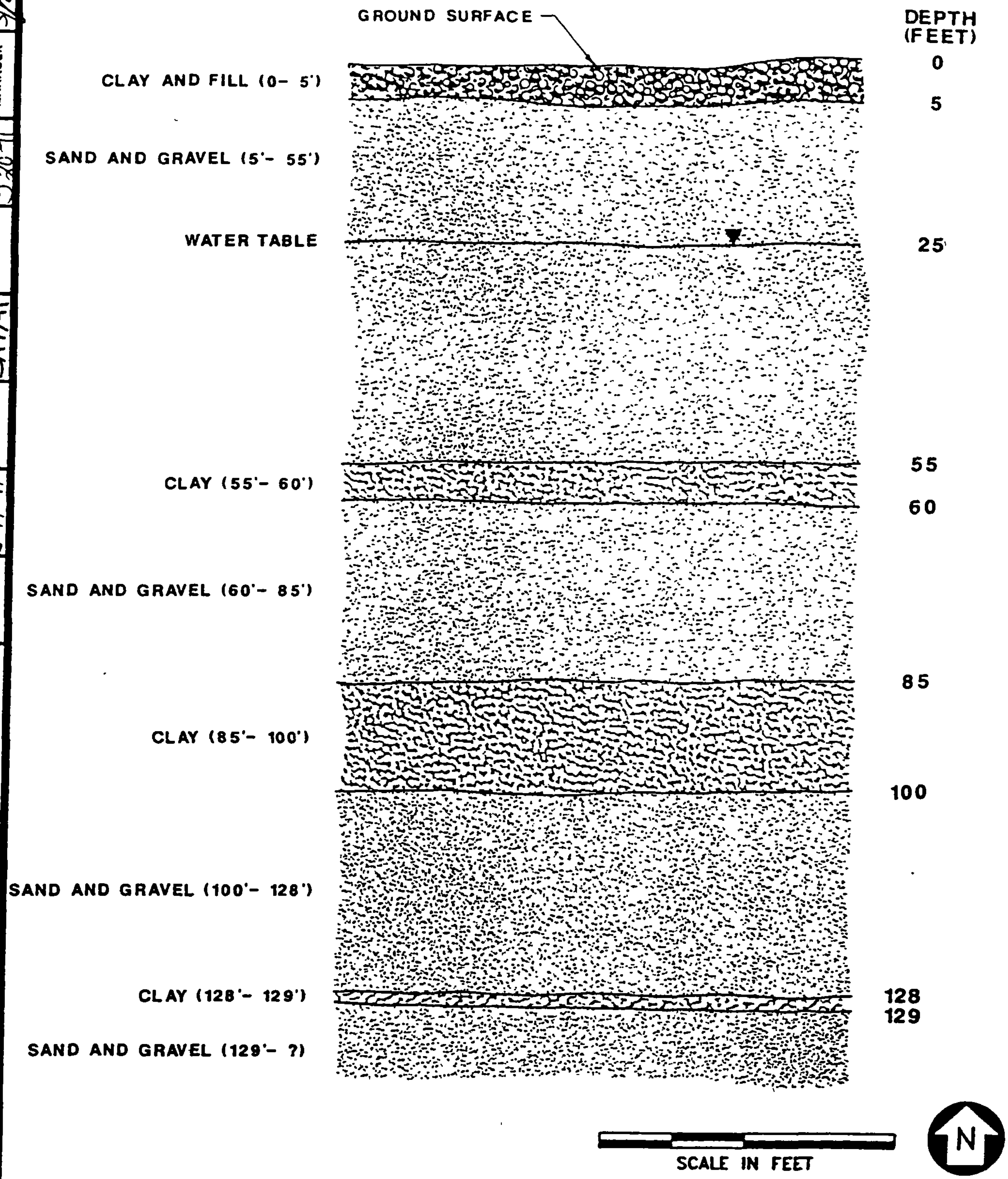

| | |
|---|---|
| REV. | B |
| DATE | 5/15/91 |
| DRAWN BY | TMM 5-17-91 |
| CHECKED BY | PTS 5/17/91 |
| DOCUMENT MANAGER | SG 5-20-91 |
| PROJECT MANAGER | 5/20/91 |

John Mathes & Associates, Inc.

1,2-DICHLOROETHANE CONCENTRATION (ug/L) IN GROUNDWATER

ACUSTAR
DAYTON, OHIO
423023

FIGURE 40




John Mathes & Associates, Inc.

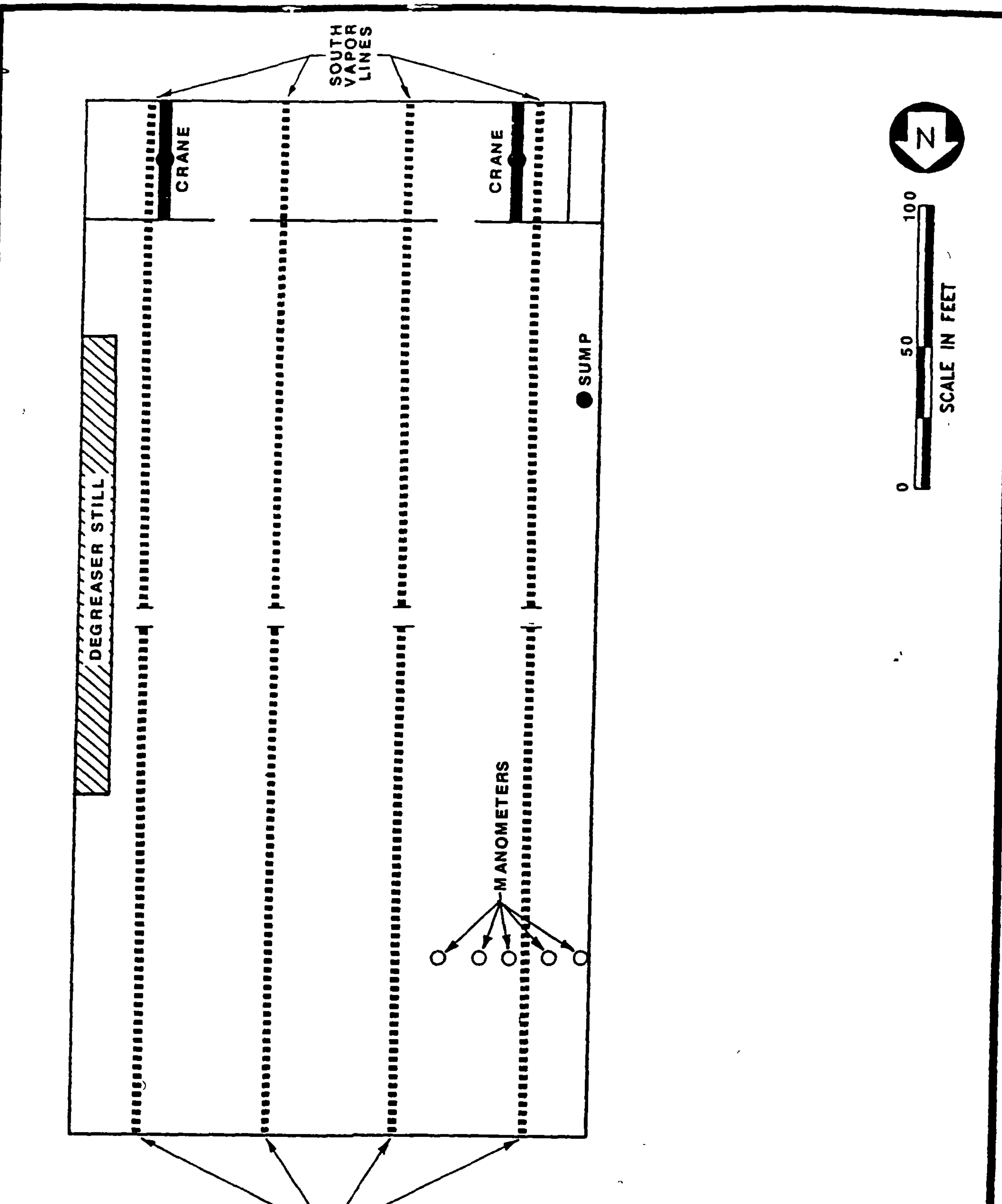
**CONCEPTUAL SUBSURFACE CONDITIONS DAYTON THERMAL PRODUCTS PLANT**

| | |
|---|---|
| ACUSTAR<br>DAYTON, OHIO<br>423023 | FIGURE 41 |

| | |
|---|---|
| DRAWN BY | 5-17-91 |
| CHECKED BY | PTS 5/17/91 |
| DOCUMENT MANAGER | SG 5.20.91 |
| PROJECT MANAGER | 5/20/91 |

Stratigraphy conceptualized from Building 50 Water Supply Well Boring Log.

DRAWN BY: IMM 5-17-91
CHECKED BY: PTS 5/17/91
DOCUMENT MANAGER: SG 5-20-91
PROJECT MANAGER: 5/20/91



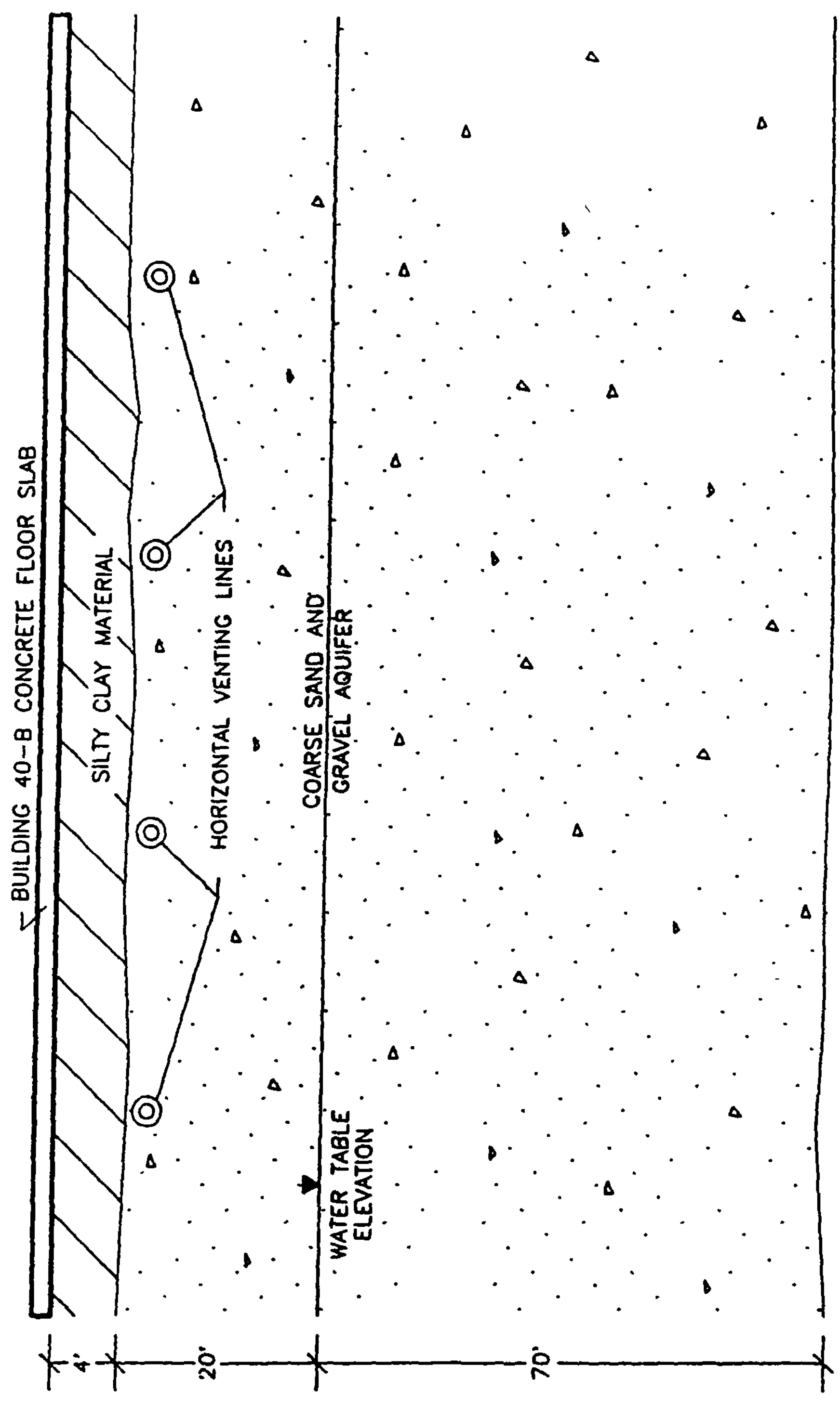

John Mathes & Associates, Inc.

**PROPOSED LOCATIONS FOR HORIZONTAL VAPOR REMOVAL LINES IN BUILDING 40-B**

ACUSTAR
DAYTON, OHIO
423023

FIGURE 42

| REV. | DATE | DRAWN BY | CHECKED BY | DOCUMENT MANAGER | PROJECT MANAGER |
|---|---|---|---|---|---|
| D | 5/2/91 | TAM 5-17-91 | PTS 5/17/91 | SG 5/21/91 | JLR 5/20/91 |



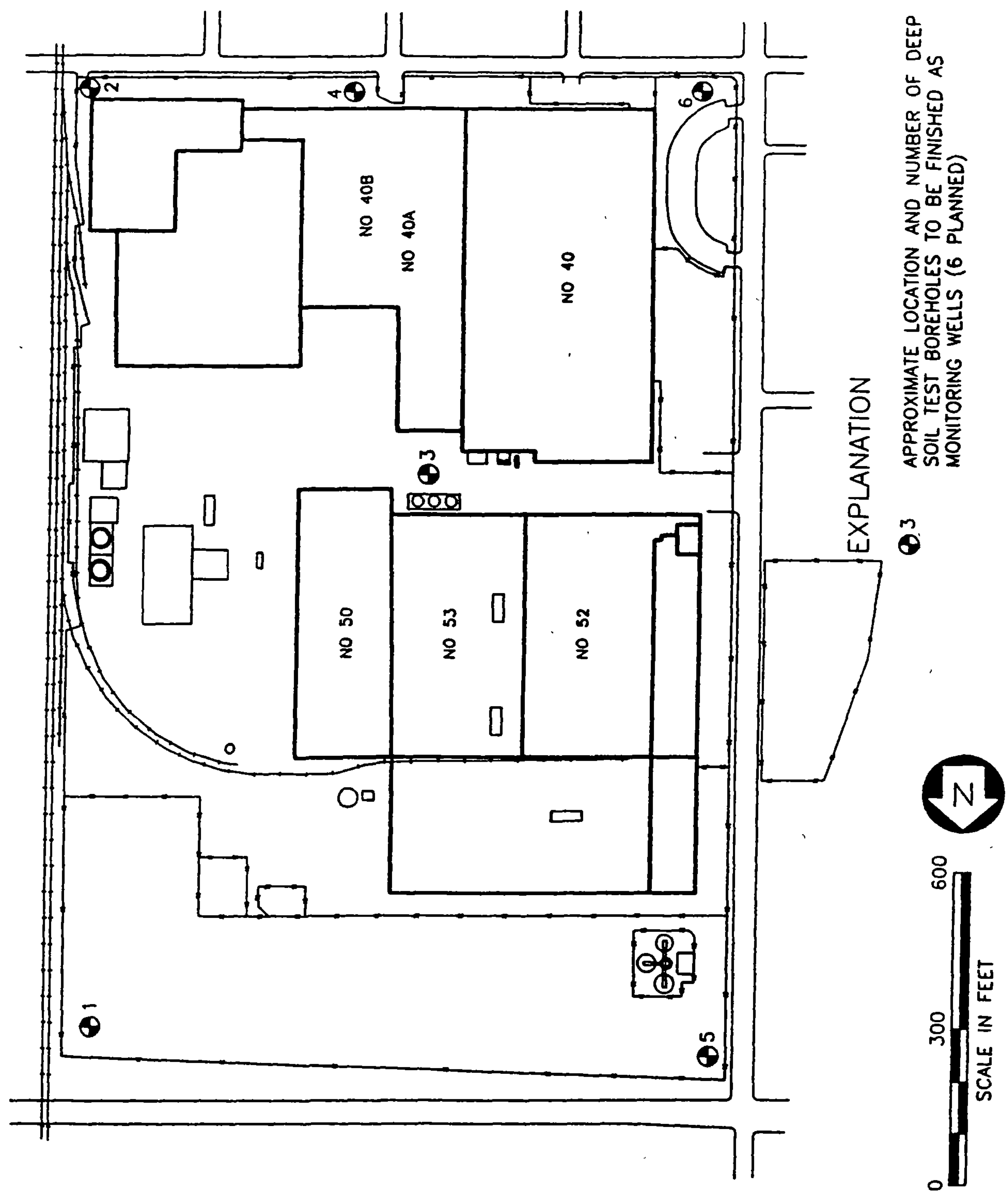

NOT TO SCALE

John Mathes & Associates, Inc.

CROSS SECTIONAL DIAGRAM OF PROPOSED VENTING SYSTEM

ACUSTAR
DAYTON, OHIO
423023

FIGURE 43




| B REV. DATE | DRAWN BY | CHECKED BY | DOCUMENT MANAGER | PROJECT MANAGER |
|---|---|---|---|---|
| 5/16/91 | TMM 5-17-91 | DTS 5/17/91 | SL 5-20-91 | 5/20/91 |

John Mathes & Associates, Inc.

PROPOSED LOCATIONS OF DEEP SOIL TEST BOREHOLES AND INITIAL MONITORING WELLS

ACUSTAR
DAYTON, OHIO
423023

FIGURE 44

STATUS REPORT AND RECOMMENDATIONS
ENVIRONMENTAL SITE ASSESSMENT

DAYTON THERMAL PRODUCTS DIVISION
DAYTON, OHIO

ACUSTAR, INC.
CHRYLSER MOTORS CORPORATION

August 16, 1991

Prepared for:

ACUSTAR, INC.
1600 Webster Street
Dayton, Ohio 45404

Project 423023

JOHN MATHES & ASSOCIATES, INC.
East Park One Building
701 Rodi Road, Suite 101
Pittsburgh, Pennsylvania 15235-4559
(412) 824-0200

# BACKGROUND

- Old Maxwell Complex demolition to make space for Building 59
- Discovery of VOC and TPH contamination in areas of:
  - Concrete Slabs
  - Sewer Lines
  - Process Pipelines
  - Process Sumps
  - Nonhazardous Waste Storage Pad
  - Oil/water Separator
  - TCA Tank
  - Flux Room
  - New Product Barrel Storage
  - Battery Storage
- Soil in Footprint of Building 59
- Soil in adjacent areas to be paved

# REMEDIAL ACTIVITIES TO DATE

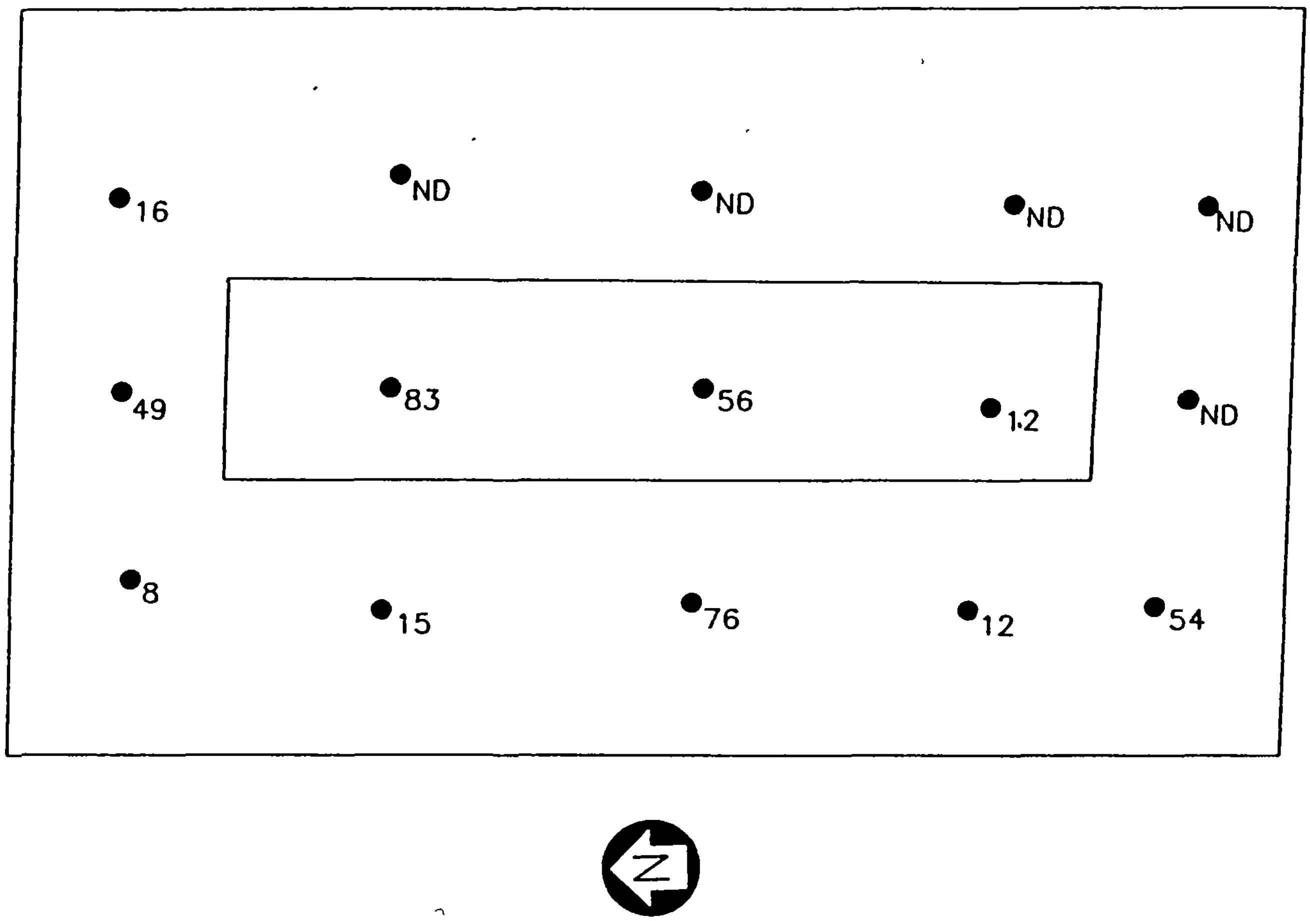
- Special Waste
  - Shipments to Pinnacle Road Landfill
    166 loads (~$25/cubic yard)

- Hazardous Waste
  - Soil
    F001 from 40B
    5 loads ($1,200-$1,500 per cubic yard)

  - Concrete
    Chromium leach
    Lead leach
    11 loads to date ($300-$500 per cubic yard)
    7 additional loads being evaluated

- On-Site Treatment of TPH and VOC Contaminated Soil
  - Building 59 Footprint
  - Adjacent areas to be paved

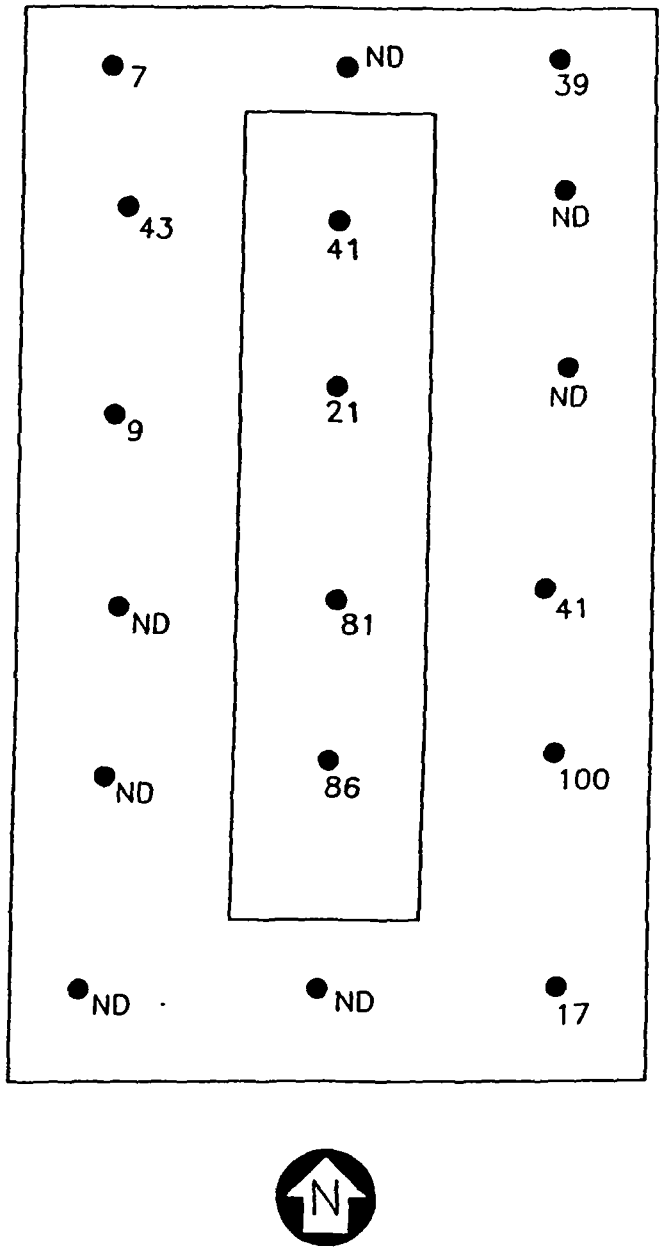
# CLEAN SOIL STOCKPILE




EXPLANATION


APPROXIMATE SAMPLE LOCATION WITH TOTAL VOLATILE ORGANIC COMPOUNDS (METHOD 8240) IN ug/kg

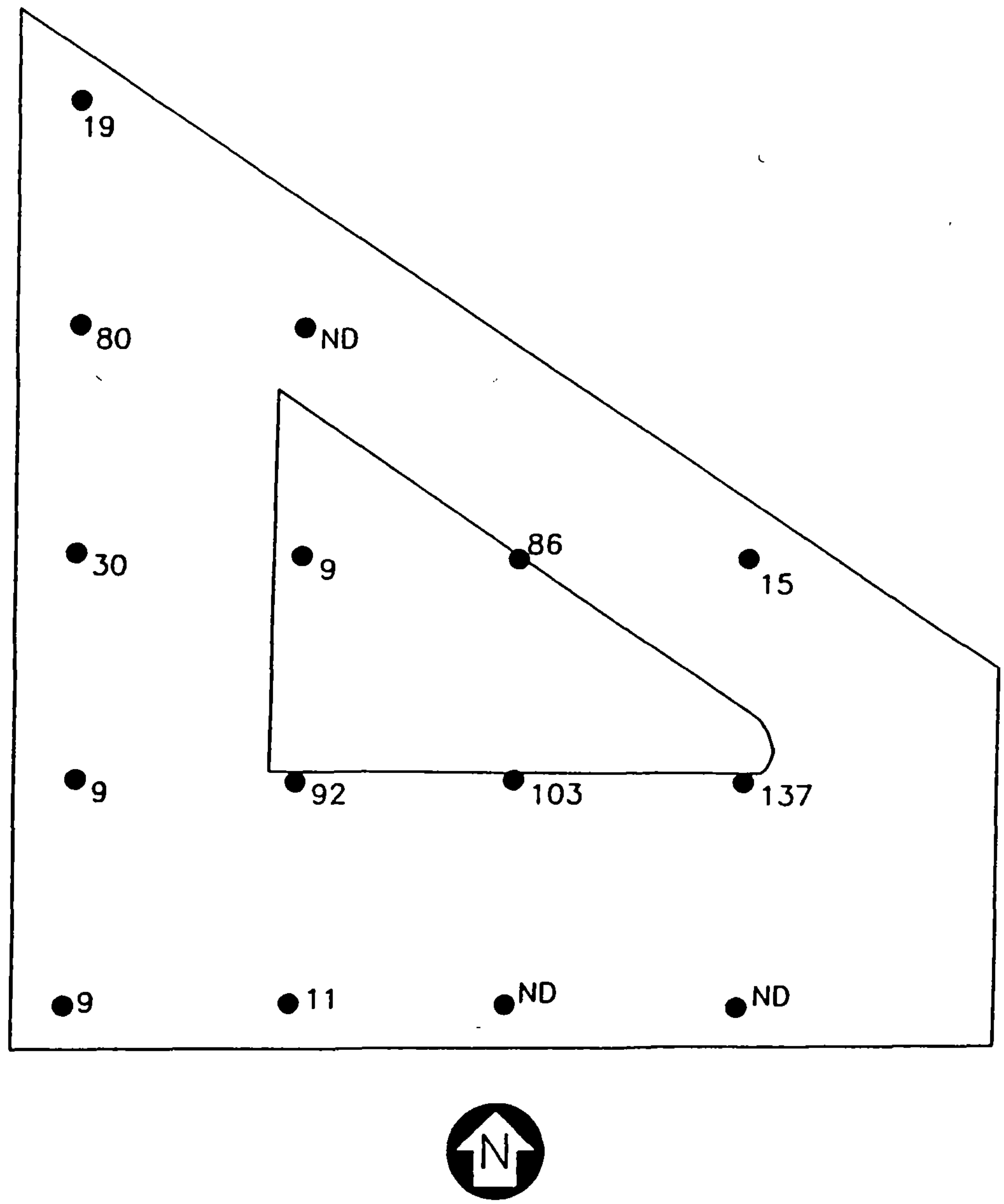
# VOC VACUUM EXTRACTION BED




EXPLANATION


APPROXIMATE SAMPLE LOCATION WITH TOTAL VOLATILE ORGANIC COMPOUNDS (METHOD 8240) IN ug/kg

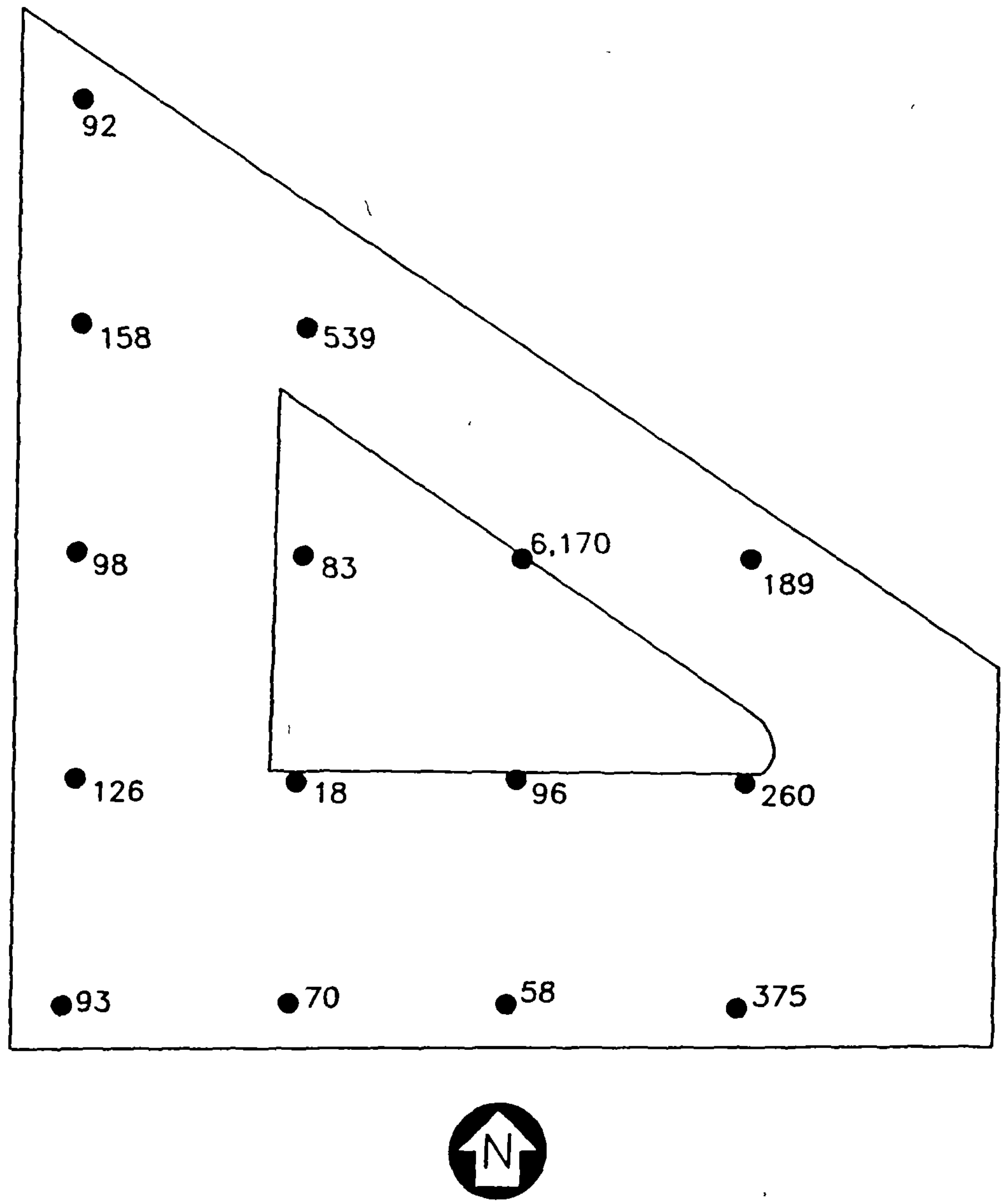
# TPH VACUUM EXTRACTION BED




EXPLANATION

●9 APPROXIMATE SAMPLE LOCATION WITH TOTAL VOLATILE ORGANIC COMPOUNDS (METHOD 8240) IN ug/kg

# TPH VACUUM EXTRACTION BED




EXPLANATION

●93 · APPROXIMATE SAMPLE LOCATION WITH
TOTAL PETROLEUM HYDROCARBONS (METHOD 418.1)
IN mg/kg

# EXPANDED SITE INVESTIGATION

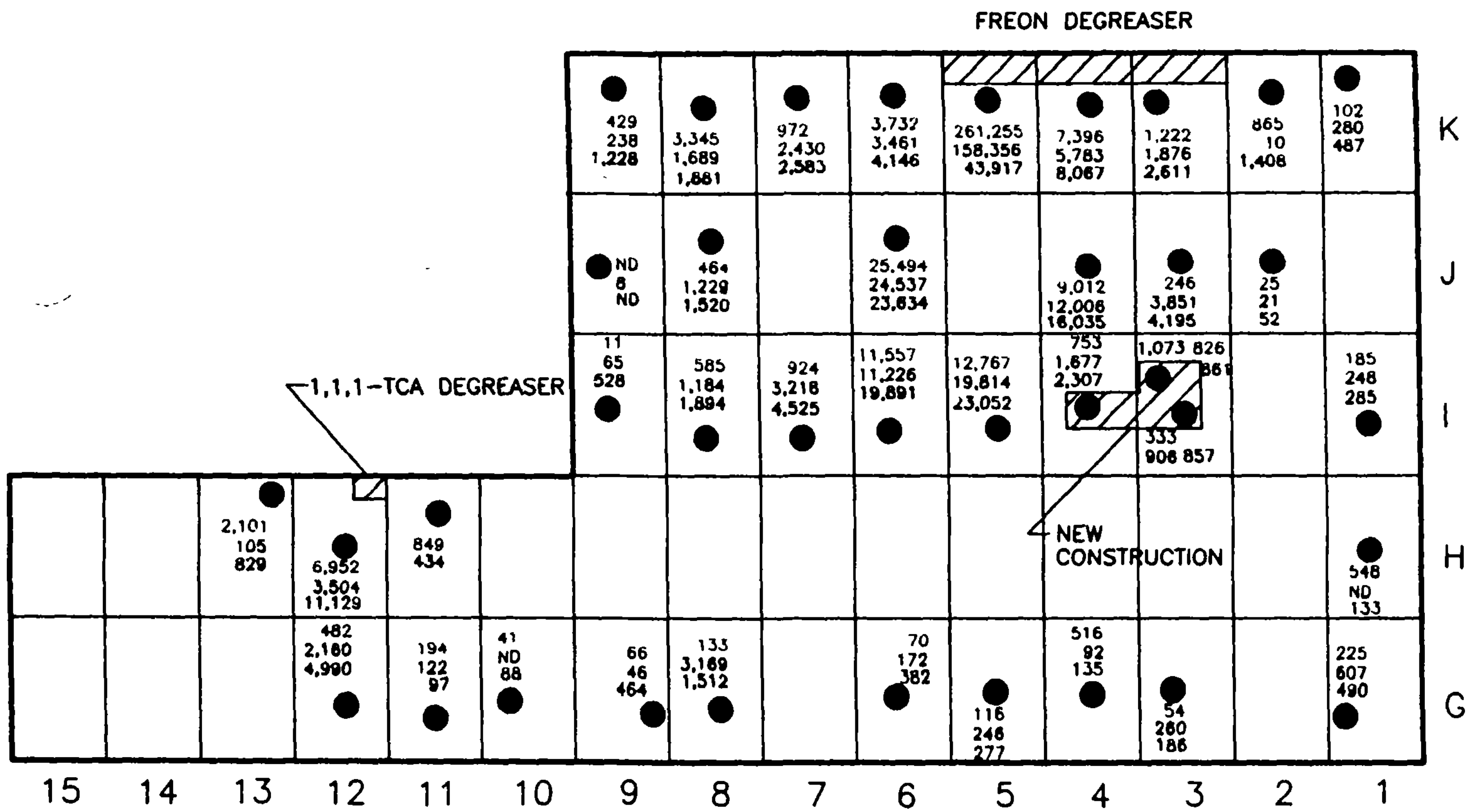
- RECON — Buildings 40A and 40B
  - Soil Gas

- RECON - Site-Wide Reconnaissance
  - Soil Gas
  - Groundwater

- Literature Review
  - Conceptual Subsurface Model

- Surrounding Properties

# TOTAL VOCs IN SOIL GAS USING RECON℠ - BUILDING 40A & 40B DAYTON THERMAL PRODUCTS PLANT




## EXPLANATION

● APPROXIMATE RECON℠ SAMPLE LOCATION

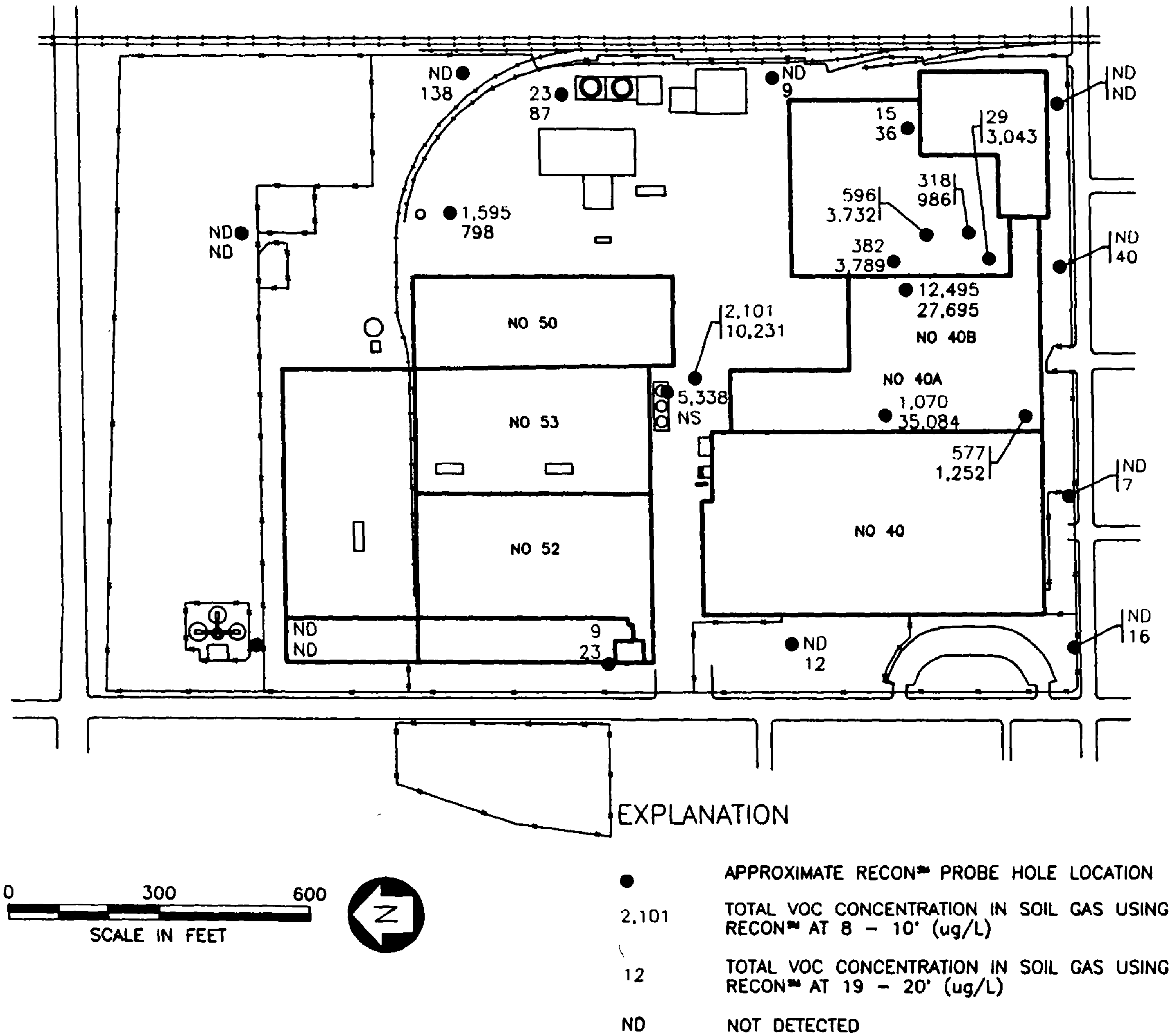
116 TOTAL VOCs DETECTED IN SOIL GAS USING RECON℠ AT 0 – 1' (ug/L)

172 TOTAL VOCs DETECTED IN SOIL GAS USING RECON℠ AT 3 – 4' (ug/L)

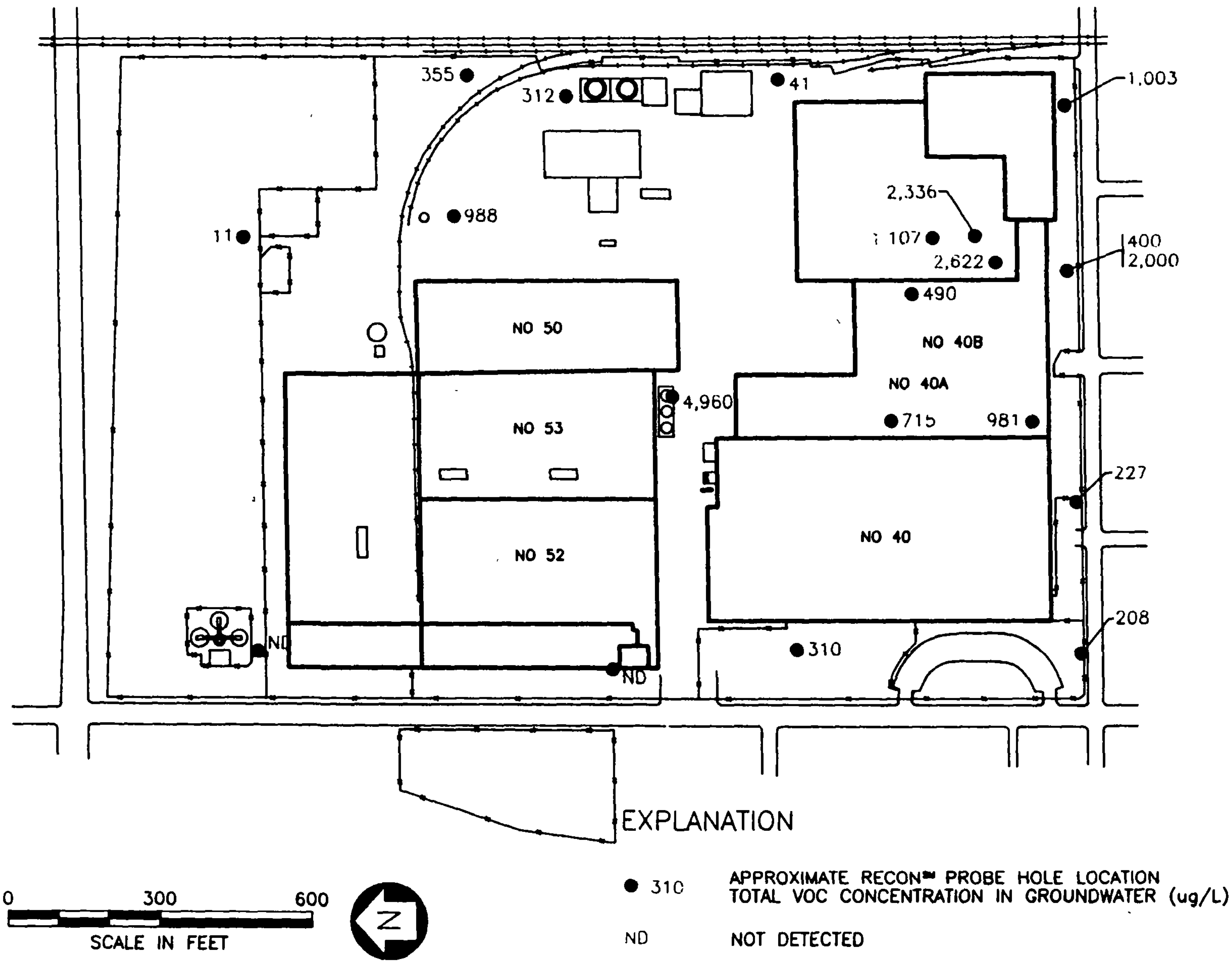
382 TOTAL VOCs DETECTED IN SOIL GAS USING RECON℠ AT 6 – 7' (ug/L)

ND NOT DETECTED

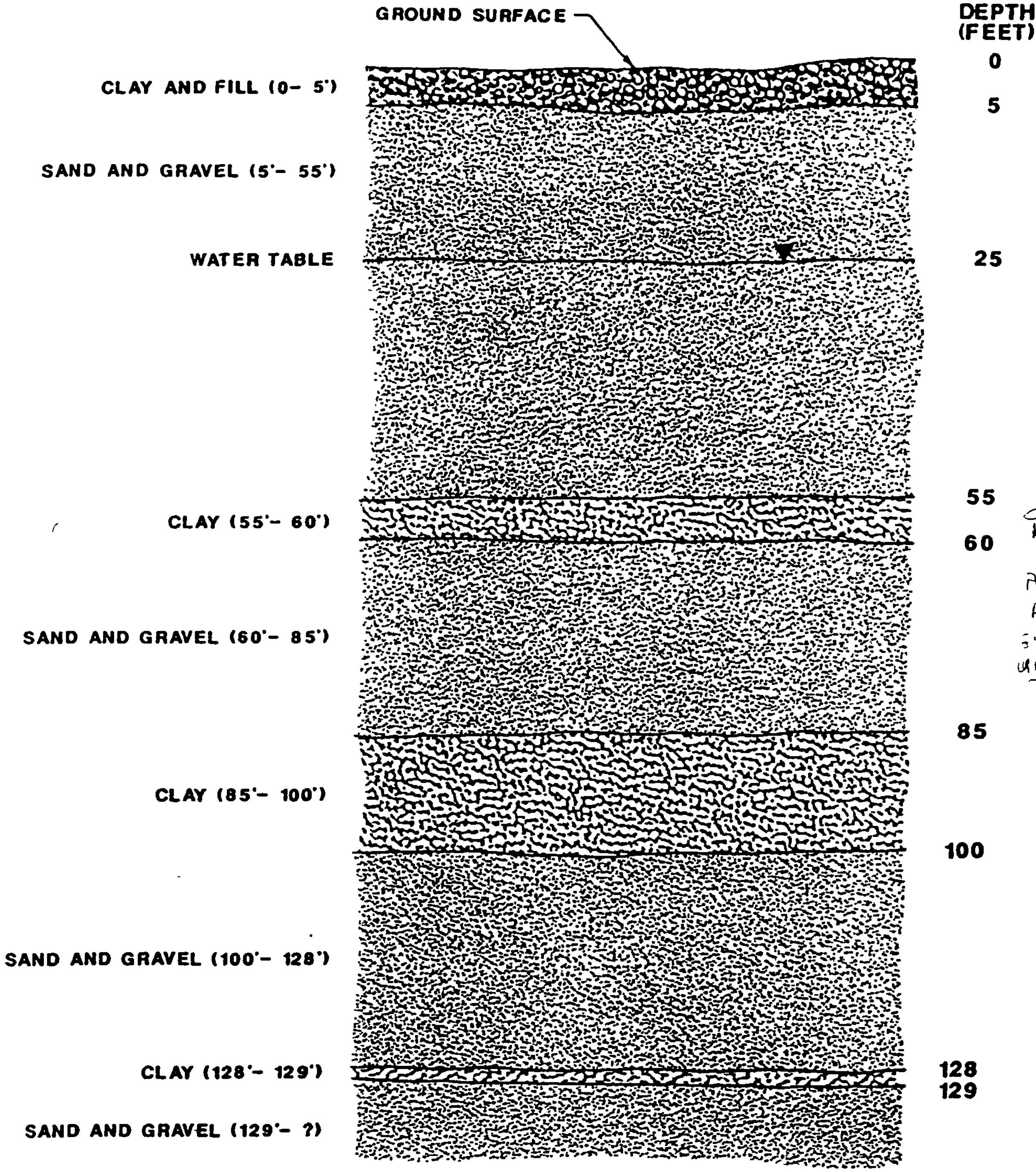
# TOTAL VOCs IN SOIL GAS
# DAYTON THERMAL PRODUCTS PLANT



# TOTAL VOCs IN GROUNDWATER
# DAYTON THERMAL PRODUCTS PLANT



# CONCEPTUAL SUBSURFACE CONDITIONS
# DAYTON THERMAL PRODUCTS PLANT

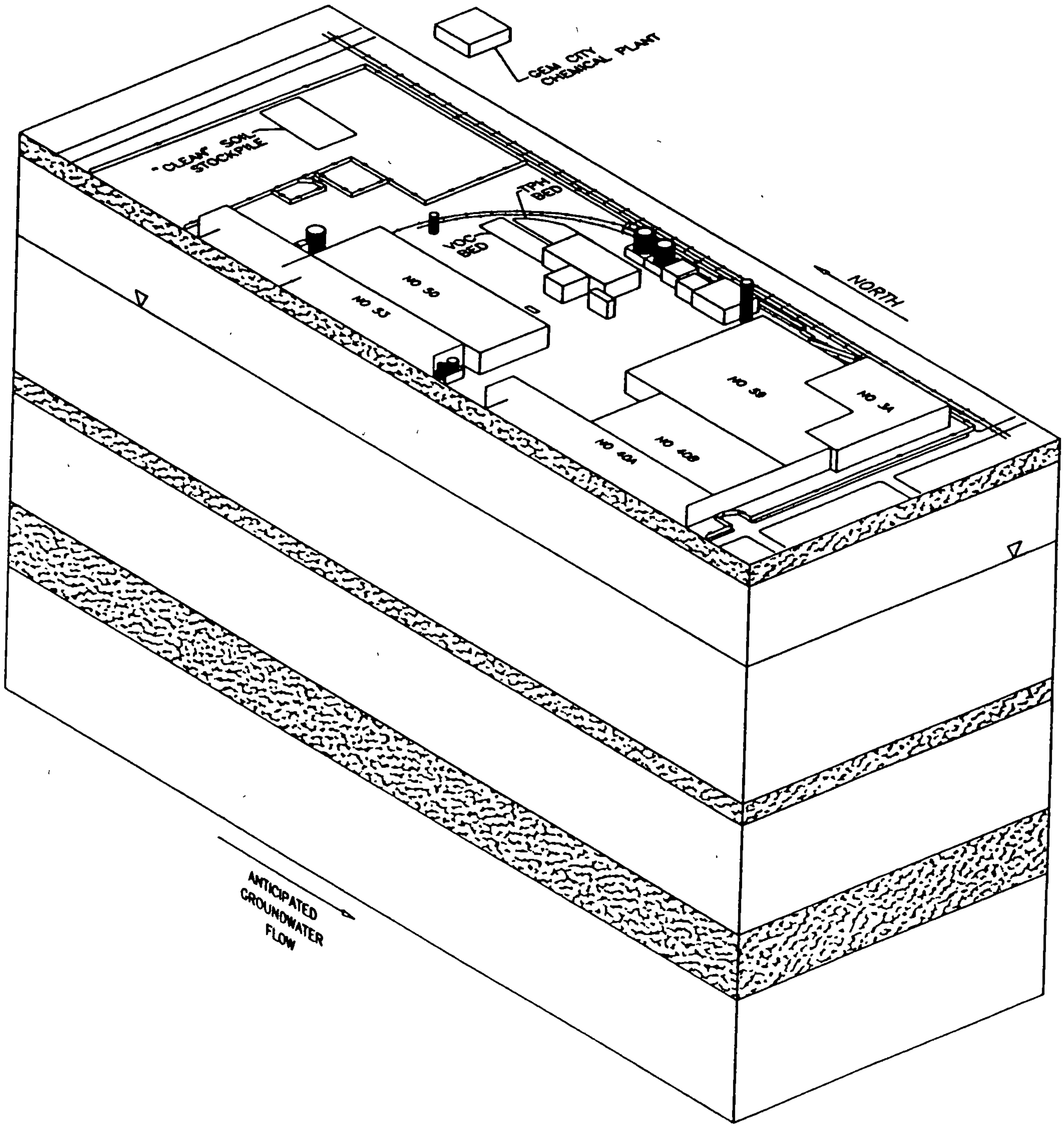



LAYER

AQUIFER

UNDER PRESSURE

# CONCEPTUAL SUBSURFACE CONDITIONS
# DAYTON SITE



# ADDITIONAL WORK RECOMMENDED

- Prevent Identified Sources From Contaminating Aquifer — Source Control
  - 1,1,1-TCA tanks south of Building 59
  - Building 40B

- Evaluate Subsurface Conditions
  - Vertical profile and lateral extent of sediments. Delineate aquifer and semi-confining layer boundaries.
  - Aquifer, vadose zone and semi-confining layer properties:
    1. Air flow for soil venting
    2. Groundwater flow in water table and first semi-confined aquifer for groundwater remediation
    3. Semi-confining layer properties and orientation for non-aqueous phase contaminant flow

- Evaluate Risks and Options

- Select Cost-Effective Alternative(s)

# SOURCE CONTROL
# 1,1,1-TCA TANKS

OPTIONS

1. Tank System as a continuing source

   - Remove from service
   - Integrity Test
     - visual inspection
     - corrosion
     - improve material management

2. Subsurface Contamination

   - Soil

     - Excavation/removal (RCRA hazardous waste)

       Assume 100 x 100 x 25 ~ 9,000 yards
       $1,200/cubic yard for incineration

       ~$11 Million

     - Venting (minimize RCRA hazardous waste)

       ~$50,000 as part of program outlined below

   - Groundwater

     - To be selected as part of site-wide evaluation

# SOURCE CONTROL
# BUILDING 40B

## OPTIONS

1. Building as a Continuing Source

   - Remove from service
     - improve material management practices
     - discontinue use of solvents
     - halt production

   - Isolate from environment
     - venting system discussed below

2. Subsurface Contamination

   - Soil
     - 127,000 cubic yards may be affected
     - All subsurface work will generate RCRA hazardous waste (requires handling at $1,200-1,500/cubic yard)
     - Excavation/Removal
       All RCRA hazardous waste - $152 million
     - Venting
       Minimize generation of RCRA hazardous waste - $0.7-$1.5 million

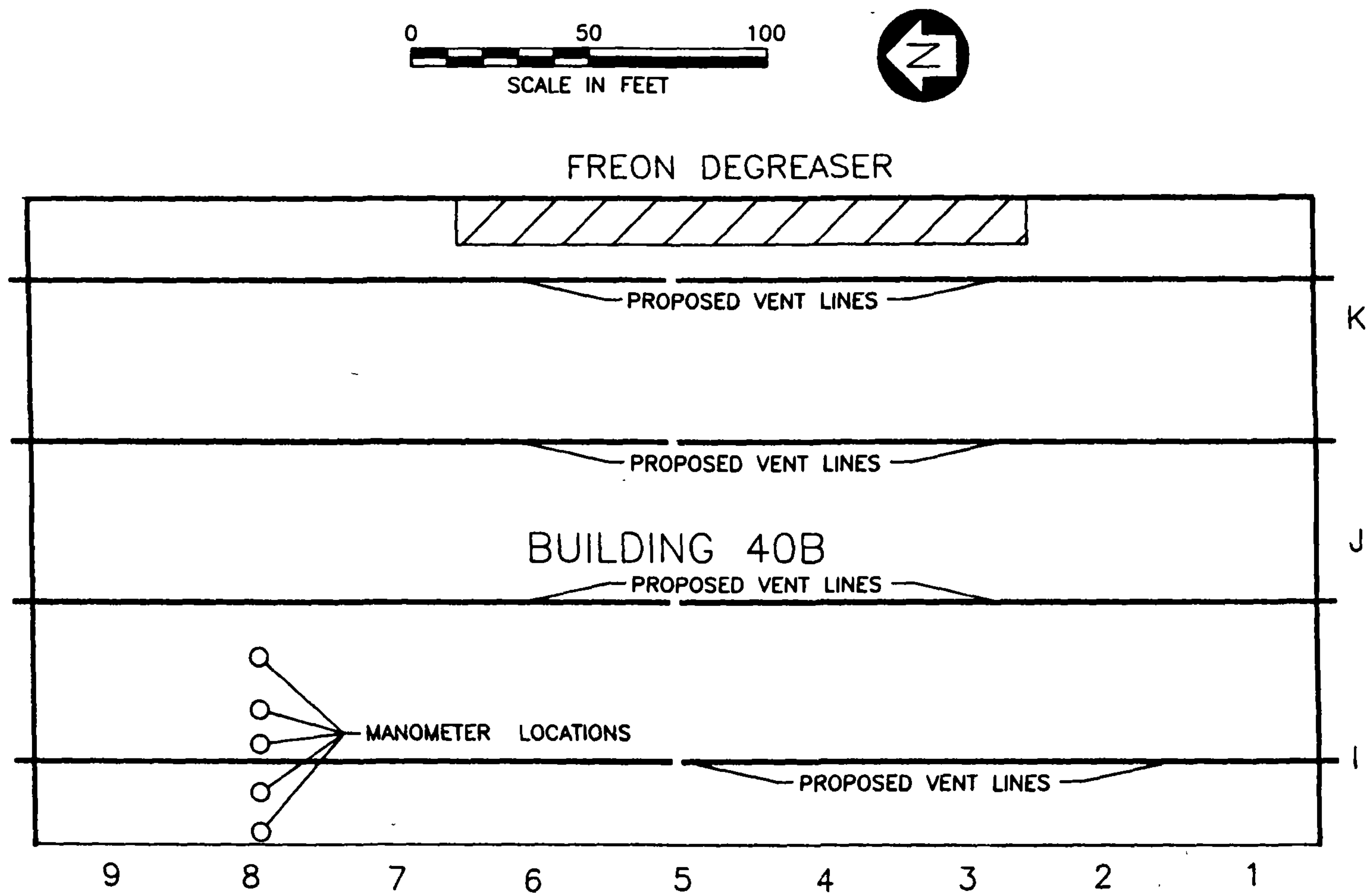
       a. Vertical - not most cost-effective option due to site logistics

       b. Horizontal
          - from surface - infeasible logistically
          - from outside of building

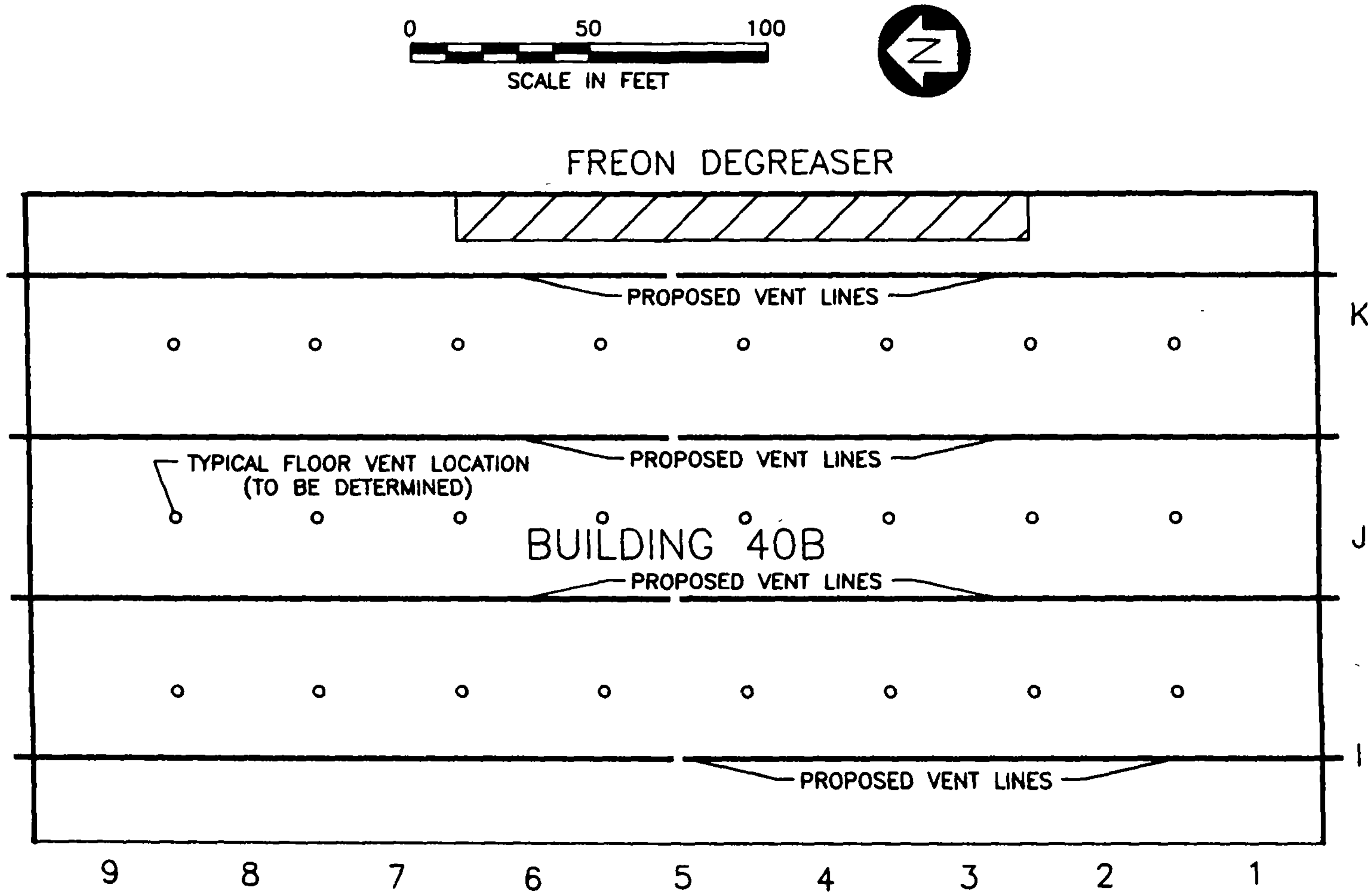
       Program outlined below

   - Groundwater
     - To be selected as part of site-wide evaluation

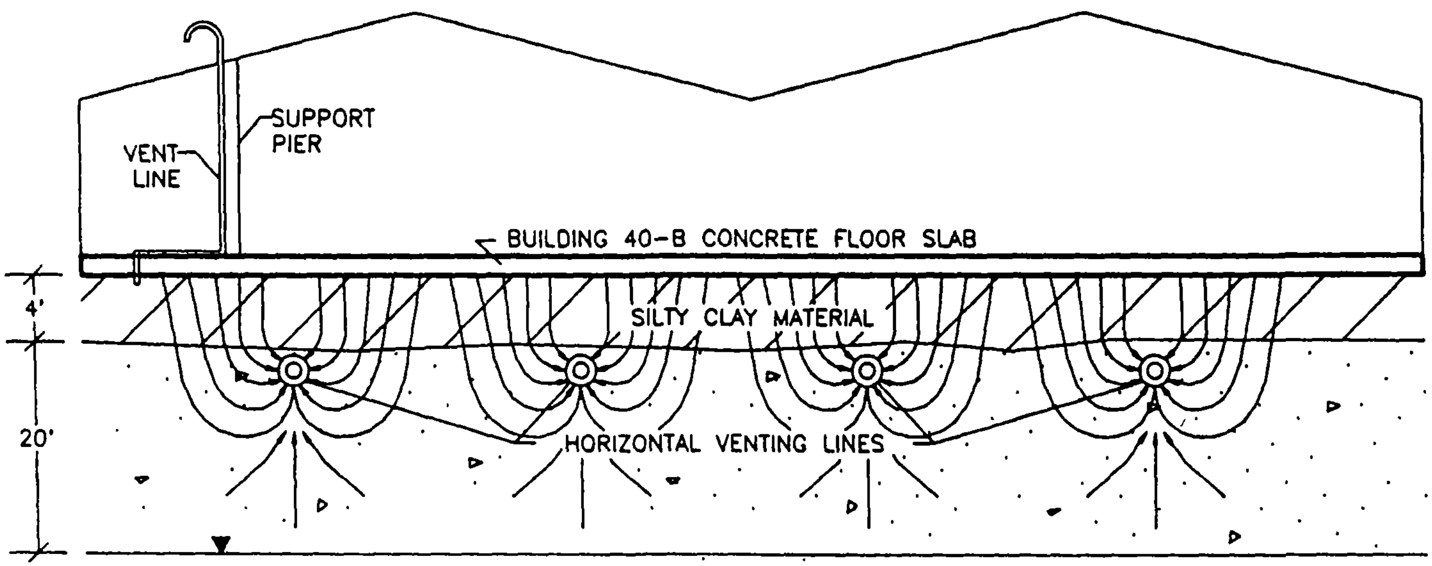
# PROPOSED LOCATION FOR HORIZONTAL VENTING LINES HORIZONTAL SOIL VENTING SYSTEM



# TYPICAL FLOOR VENTING LOCATION
# HORIZONTAL SOIL VENTING SYSTEM



# CROSS SECTION DIAGRAM OF PROPOSED VENTING SYSTEM




NOT TO SCALE

# SUBSURFACE ASSESSMENT AND CLEANUP EVALUATION ANTICIPATED SCOPE OF WORK

- Evaluate subsurface soil condition in area of 1,1,1-TCA tanks and storage area east of Building 50
  - VOCs
  - Grain size distribution
  - Response testing (venting test)
    - to evaluate, design, and cost soil venting as a remedial alternative

- Advance deep (100 feet) boreholes to evaluate continuity of stratigraphy
  - Six boreholes through base of "confined" saturated zone
  - Evaluate data requirements
  - Install wells

- Advance shallow (55 feet) boreholes to evaluate water table and continuity of confining zone
  - Six boreholes to base of first "confining" layer
  - Evaluate data requirements
  - Install wells

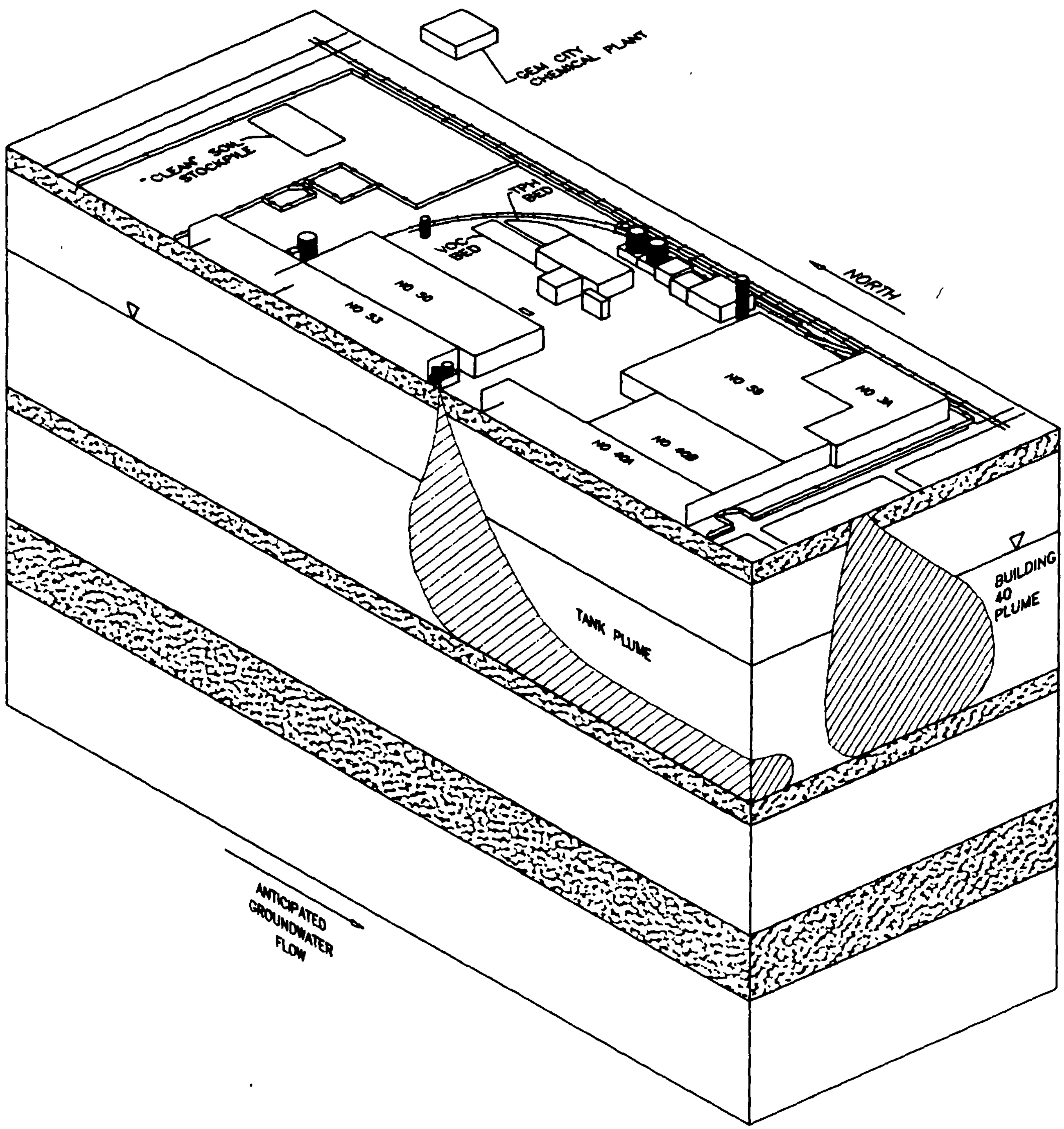
- Evaluate groundwater and properties of water table and first "confined" zone
  - Flow direction
  - Water quality (VOCs plus parameters required for remediation)
  - Response testing (pumping test)
    - to select and design appropriate remedial method

- Evaluate cleanup standards
  - ARARs
  - RCRA Corrective Action Levels
  - Health-risk based levels

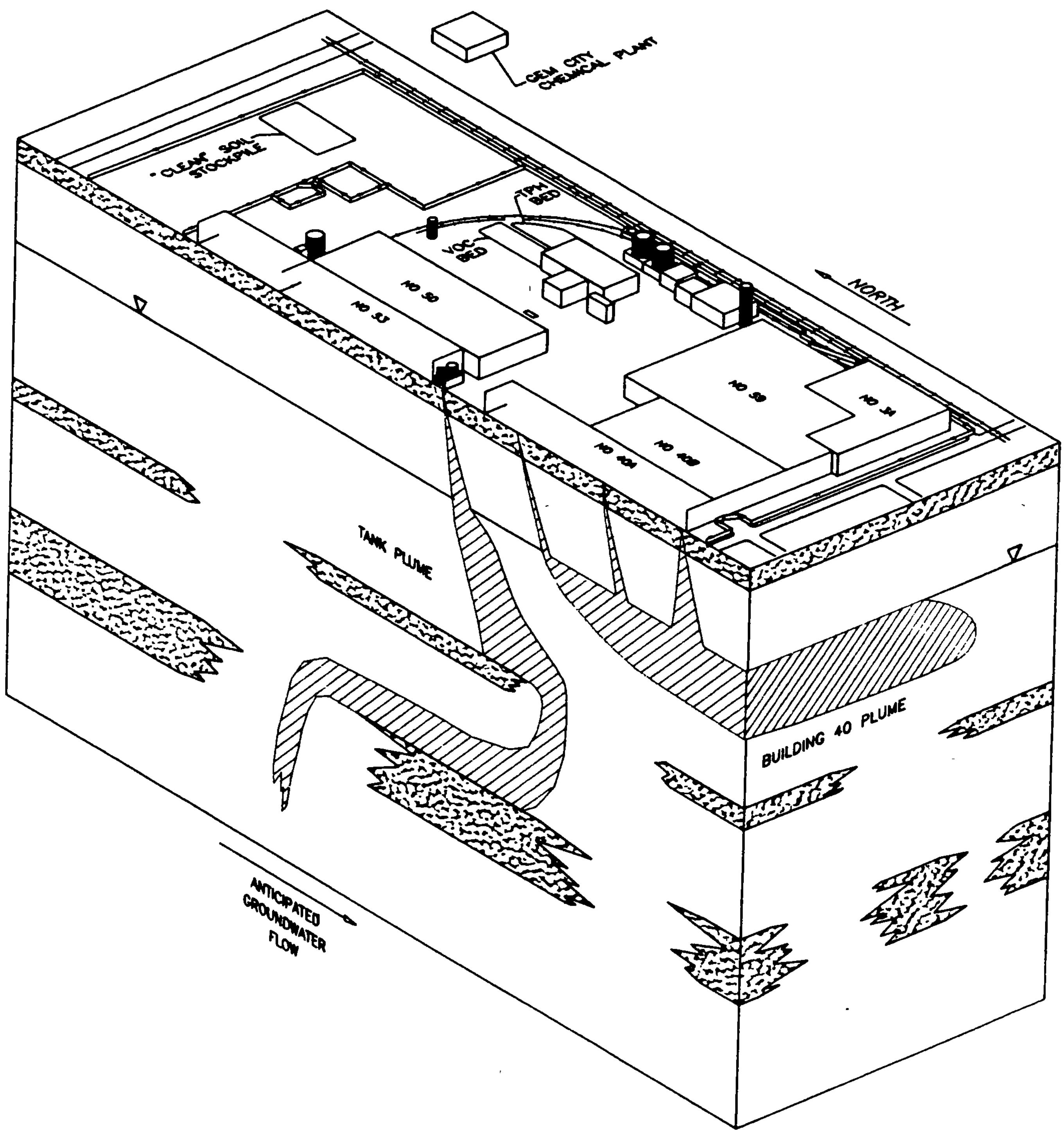
- Engineering evaluation
  - Soil
  - Groundwater

- Recommendations

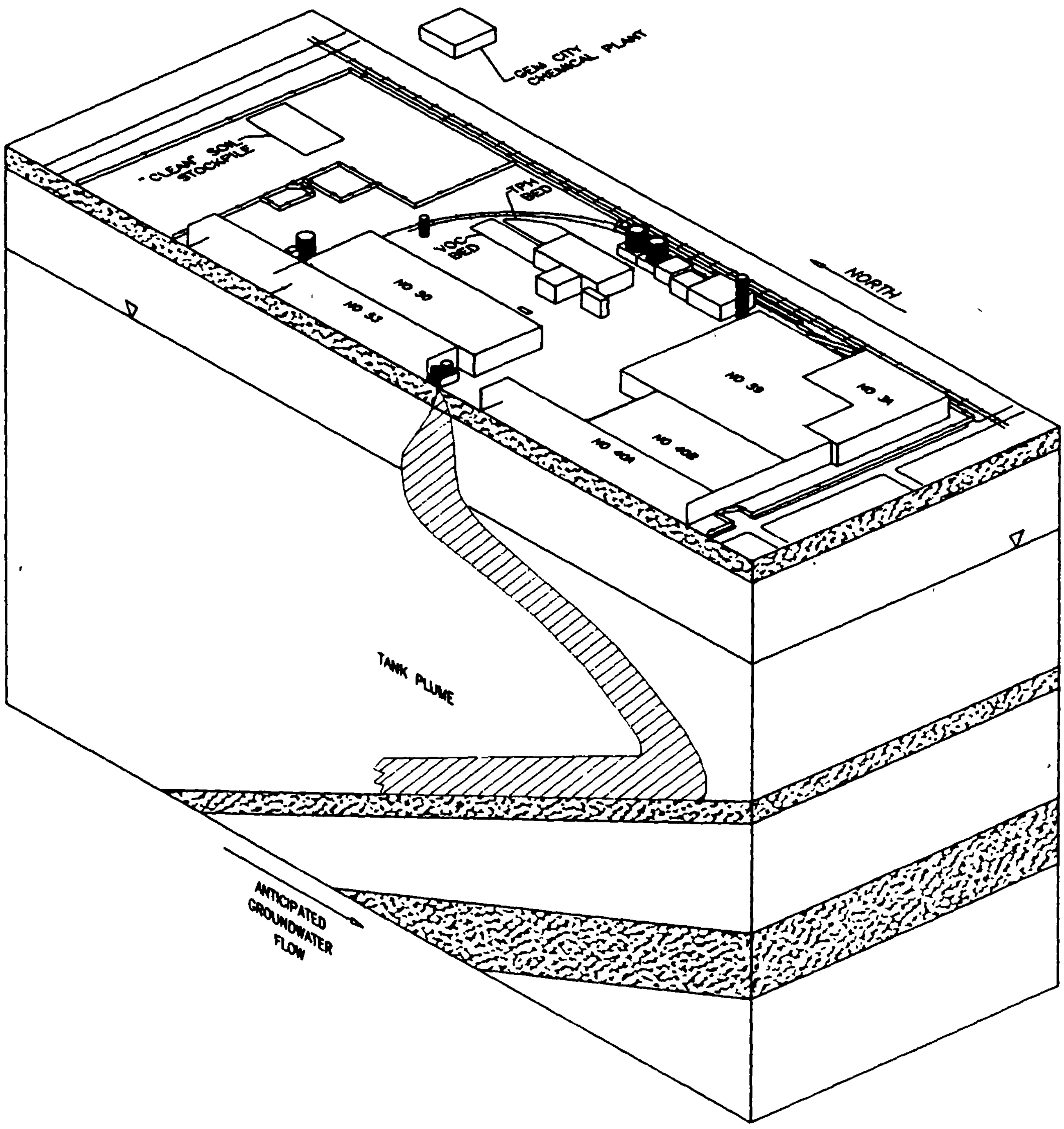
# CONCEPTUAL SUBSURFACE CONDITIONS
# DAYTON SITE
# "HORIZONTAL" CONFINING LAYER



# CONCEPTUAL SUBSURFACE CONDITIONS
# DAYTON SITE
# "LEAKY" CONFINING LAYER



# CONCEPTUAL SUBSURFACE CONDITIONS
# DAYTON SITE
# "TILTING" CONFINED LAYER



# DRIVING FORCES/CONCERNS

- Release of hazardous substance/waste to the environment

- Affects groundwater above federally promulgated maximum contaminant levels (MCLs) (drinking water)

- Previously pumped contaminated Power House well for 90 days @ 1 million gallons per day - no change in contaminant level (large volume affected)

- Potential for off-site migration
  - increases difficulty ($) of recovery

- Minimize potential Superfund "PRP" responsibility/ participation of Dayton aquifer remediation

- Evaluate "Island of Purity" concept
  - remediate media affected by plant

# SITE ASSESSMENT SUMMARY

**Prepared for**
Acustar - Dayton Thermal Products Division
1600 Webster Street
Dayton OH 45404

**Prepared by**
Clean Tech
2700 Capitol Trail
Newark DE 19711
(302) 999-0924

**February, 1994**

(Chrysler\Dayton\SI1093 rpt)

# Table of Contents

CLEAN TECH

Clean Tech Inc
Environmental Consultants

2700 Capitol Trail
Newark DE 19711
302•999•0924
FAX 302•999•0925

February 2, 1994

Mr. Luther L. Blair
Manager - Environmental Planning
Acustar, Inc.
1850 Research Drive
CIMS 404-01-01
Troy MI 48083

**Re:** Site Assessment Summary Final Draft

Dear Lou:

Enclosed is the final draft of the site assessment summary report which was prepared for Dayton Thermal Products Division. The report includes a review of all previous site audits, identification of on-site and off-site sources of contamination, a review of regional and local geology, and overview of remediation objectives as required by Ohio EPA, and a summary including recommendations. We have incorporated all revisions by you and Doug.

After you have reviewed the report, please contact me so that we may discuss the report.

Sincerely,

Deb

Deborah A. Buniski, P E.
President
CLEAN TECH

Enclosure

cc. D. Orf

(Chrysler\Dayton\ST1093 rpt)

**Attachments**

# SECTION 1.0 - BACKGROUND

The report was prepared by Clean Tech (CT) for the Dayton Thermal Products Plant (DTPP) located at 1600 Webster street in Dayton, Ohio This plant is a part of Acustar/Components (A/C), a division of Chrysler Corporation.

## 1.1 Purpose

DTPP requested that CT review and compile available information on the plant and surrounding sites to determine if the surrounding sites or activities at the plant may have impacted the soil or groundwater. The report's purpose was to gather additional information to complete an environmental assessment of the plant site. This report will be used as the basis for the design and implementation of a hydrogeolocial study of the facility

## 1.2 Report Preparation Methodology

The following provides a summary of the methodology and procedures used to research and compile the information contained in this report.

1. Meetings were held with key personnel to obtain background information on past and current plant operations. Personnel interviewed included Mr Douglas J Orf, Environmental Coordinator for the Dayton Plant, and Mr Luther L Blair, Manager of Environmental Planning for A/C
2. Records relating to hazardous wastes generated by the Dayton Plant during the past five years were reviewed Other reports and records reviewed included reported spills and MSDSs compiled for the facility
3. The State of Ohio Environmental Protection Agency records of surrounding sites were also reviewed for additional information The companies whose records were requested included DAP Inc , Gem City Chemical Inc , Brainerd Industries, Hohman Plating and Manufacturing Company, Gem City Stamping, Inc , American Lubricants

Company, Ris Paper Company, Angell Manufacturing Company, and Paint America Company Access to the following records for these facilities was requested: hazardous material spill reports, generator annual hazardous waste reports, agency site investigations, and studies relating to soil/groundwater remediation projects. Results of this research are presented in Section 3 2 of this report.

4. Additional information acquired and reviewed included copies of the soil survey prepared for Montgomery County (Soil Conservation Service), groundwater resources map (James J. Schmidt), Dayton North Quadrangle map (United States Geological Survey), State of Ohio Soil Contamination Regulations, Maximum Contaminant Levels (MCLs) standards for public water supplies and procedures established by the State of Ohio Division of Emergency and Remedial Response (DERR) in the identification of ARARs.

The findings and discussions are based solely on existing information. The overall objective of this report is to assemble available information which will be used to develop a hydrogeologic study to more fully characterize the Dayton plant site.

### 1.3 Report Format

Section 1 provides the purpose, methodology and format of the report Section 2 provides a brief summary of the site's history, past and current operations, and previous site investigations that were completed such as soil gas surveys, soil borings, and remediation programs Section 3 identifies plant activities which may have impacted the soil or groundwater This section also includes discussions about possible off-site sources of regulated substances which may have impacted the Dayton plant and the extent of impact at these sites

Section 4 describes the geology and hydrogeology of the immediate area as well as the region. It details the local groundwater uses and the impact of surrounding groundwater treatment systems and wellfields.

Section 5 discusses remediation objectives and the current policy at Ohio EPA concerning site investigations and remedial activities. It also includes an evaluation of what policies or regulations must be addressed before a remedial alternative is selected and implemented.

Section 6 provides an outline of the types of field investigations which would more fully characterize the site and which would delineate possible soil or groundwater contamination. It also includes a field sampling plan outline and a discussion of sampling objectives

# SECTION 2.0 - SITE DESCRIPTION

DTPP is located at 1600 Webster Street in Dayton, Ohio. The facility contains over 1.3 million square feet under roof and is located on about 60 acres. (For a site location map see Figure 1.)

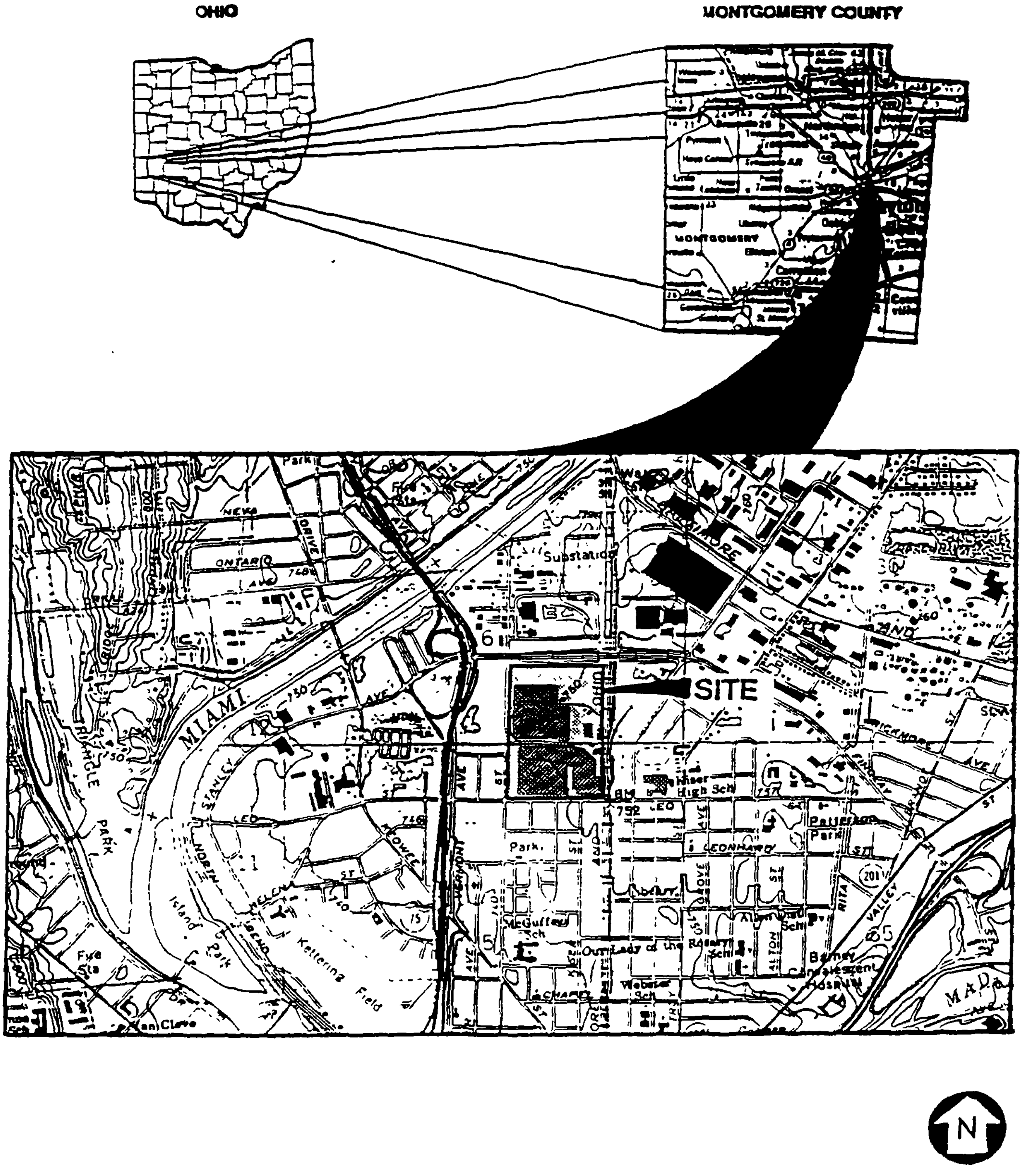
The facility is immediately surrounded by the following industries: Brainerd Industries and Paint America Company on Webster Street and American Lubricants and Gem City Chemical Company on Air City Avenue. There are several other industries and commercial operations in the vicinity (DAP, Inc., Hohman Plating and Manufacturing, Gem City Stamping, Inc , Ris Paper Company, and Angell Manufacturing Company) in addition to private residences. A facility map which provides further detail of the site including buildings and other operations is included as Figure 2.

## 2.1 Past Site History

Past operations of the plant prior to Chrysler's acquisition in 1936 included the assembly of Maxwell cars from about 1907 - 1936 The plant historically has been used for a variety of purposes including: manufacturing furnaces, gun parts, aluminum and copper tube forming operations, light machining, plating, metal stamping, welding, soldering, degreasing, painting, plastic molding, and assembly, as well as maintenance of these processes, equipment and structures. The Maxwell building complex, which was a group of twelve former buildings, was used by Chrysler until 1990 when it was demolished A portion of the former building footprint was replaced with a new manufacturing Building 59 in 1991 For the last 10 - 15 years prior to demolition, the Maxwell Complex was primarily used for storage purposes.

## 2.2 Current Plant Operations

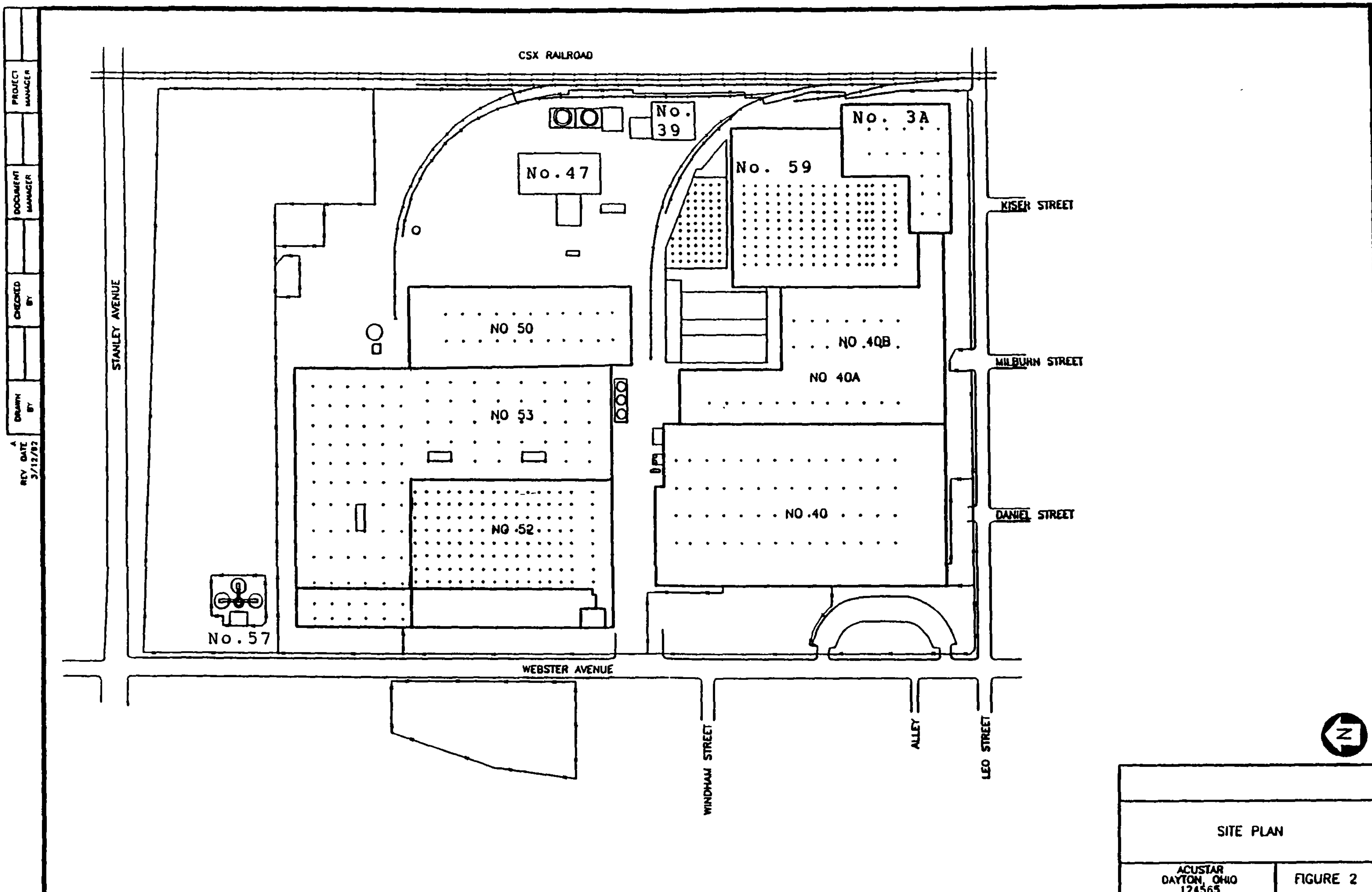
Current operations at the facility include primarily the manufacture, assembly and finishing of heat exchangers and air conditioning components for motor vehicles The facility consists of 8




SITE LOCATION MAP

Modified from U.S.G.S Geological Survey, Dayton North, Ohio quadrangle, photo revised 1981.

| | |
|---|---|
| ACUSTAR<br>DAYTON, OHIO<br>124565 | FIGURE 1 |




SITE PLAN

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FIGURE 2

manufacturing buildings, a powerhouse, wastewater treatment plant, and incidental storage buildings.

Utilities to the site are provided as follows

- Potable Water - Dayton Water Authority
- Sanitary Wastewater - City of Dayton (POTW)
- Boiler Make-up, Compressor and Non-Contact cooling water - On-site wells
- Process Wastewater - On-site Wastewater Treatment Plant

Surface water is collected through various swales and a stormwater piping system located throughout the facility. All run-off eventually enters the Greater Miami River via Lucille Street and Herman street storm sewer outfalls from Webster Street

**2.3 Previous Investigations**

It was during the demolition of the Maxwell Complex and prior to construction of Building 59 that DTPP retained Miami Geological Services, Inc. to collect soil samples, and complete soil monitoring as excavation was on-going The original scope of the investigation was confined to the demolition area which include Buildings 3, 4, 5, 6, 7, 8, 9, 10, 13, 34, 34A, 34B, and new Building 59 footprint area.

When the scope and complexity of environmental concerns increased during demolition, Burlington Environmental was retained to complete testing and analysis of the area around the Maxwell Complex The field activities were quite extensive and included the evaluation of

- Soil conditions in and around existing structures which would be removed during construction, including soils around such areas as sewer lines, pipelines, sumps, storage pads and storage areas,

- Soil conditions in areas to be excavated, including foundation areas, column piers, and adjacent paved surfaces;
- Soils remaining in-place in selected areas such as the clay soil used as part of the foundation material,
- Soil stockpiled on-site for disposal or remediation, and;
- Slabs of concrete from the demolition of the foundation of the Maxwell Complex.

The investigation of the soils during the demolition of the Maxwell Complex included:

- Test boreholes in areas which were excavated for strip foundations,
- Test boreholes in areas which were excavated for column piers;
- Soil sample testing after excavation of sewer lines, sumps, catch basins, and oil/water separators;
- Soil gas and groundwater analyses which focused on the old Maxwell Complex (new Building No. 59), several adjacent buildings (Buildings No 40A and 40B) and several other selected locations throughout the site

The initial scope of investigation was confined to the Maxwell Complex demolition site which became the new Building 59 footprint area As a result of the analysis of the soils, plant personnel became aware of potential environmental impacts. Sampling was expanded to include soil gas testing in other selected areas. Testing included 167 soil gas samples, 28 groundwater headspace samples, and 23 groundwater samples. Groundwater samples were taken as part of the soil gas investigation and did not involve placement of monitoring wells Soil gas and groundwater headspace samples were analyzed for volatile organics Groundwater samples were retrieved through the soil gas probe and submitted for laboratory analysis for volatile organic compounds (VOCs) Figure 3, from the Mathes/Burlington soil gas investigation report, contains the sampling locations from April, 1991

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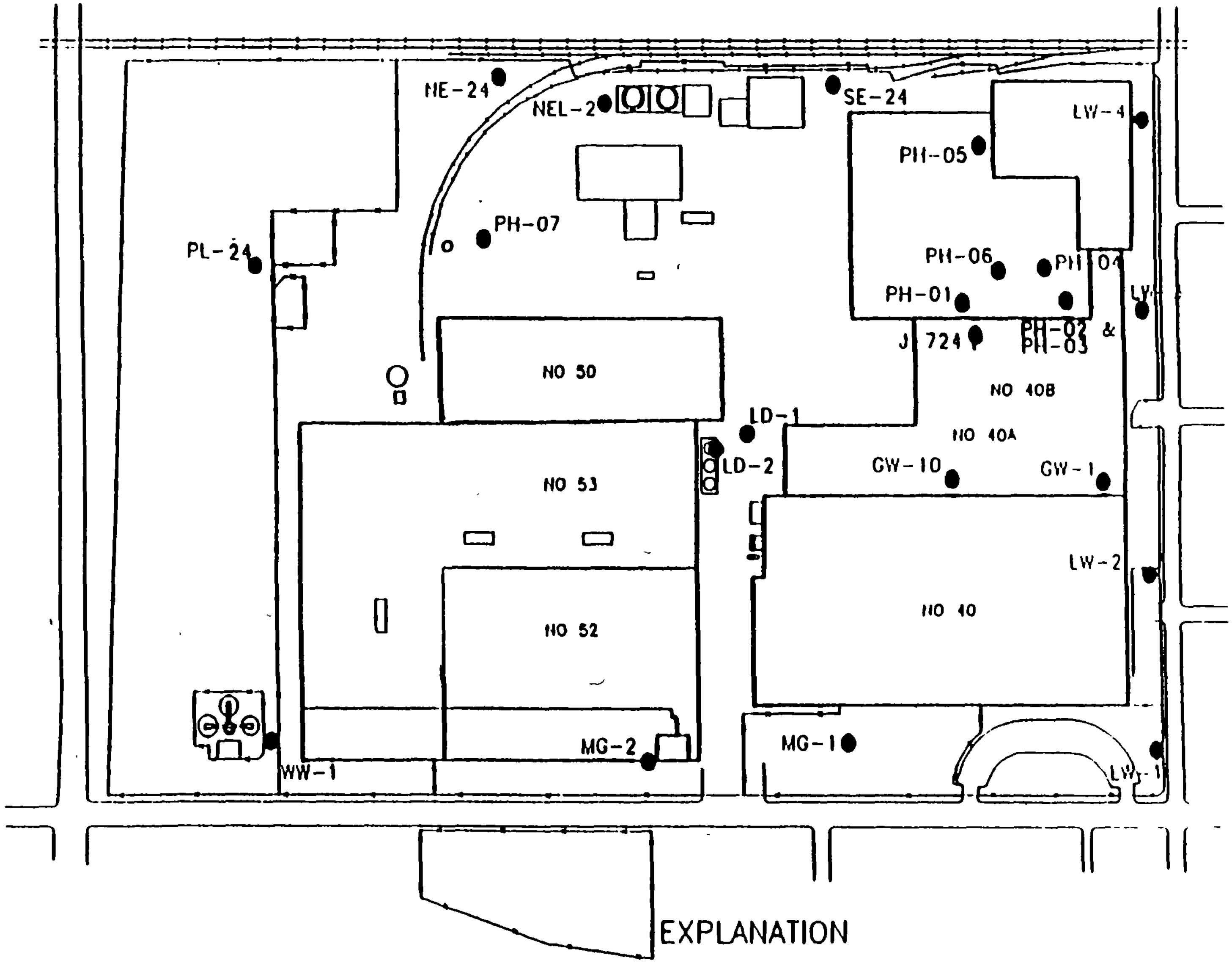


EXPLANATION

● APPROXIMATE SOIL GAS PROBE HOLE LOCATION AND NUMBER

N

NOTE: Soil gas and groundwater headspace samples were collected from PH-02 and groundwater samples were collected from PH-03

SAMPLING LOCATIONS

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FIGURE 3

Testing focused on the Maxwell Complex area and adjacent Buildings 40A and 40B as well as other locations throughout the site as noted in Figure 3 Soil gas samples from Buildings 40A and 40B were taken at 0 - 1 foot, 3 - 4 foot, and 6 - 7 foot depths. Additional soil gas sample locations throughout the site were taken at 8 to 10 foot and 19 to 20 foot depths. Groundwater samples were generally taken at 24 - 25 foot depths and included groundwater headspace testing. Groundwater samples were taken at 29 - 30 foot depths at each of three locations noted. The test results which were not sampled and analyzed according to U S. EPA methodologies or protocol, indicated the following compounds may be present:

Trichloroethene (TCE)

- Soil Gas Samples - Buildings 40A and 40B (0-1', 3-4', and 6-7' depths) - Concentrations at each depth appeared to be highest on the east side of Building 40B which is adjacent to Building 59 A trichloro trifluoroethane (CFC-113) degreaser station was formerly located on the east side of Building 40B at the time of sampling. However, the degreaser system was removed from service in 1991 and replaced with an aqueous washer system.

- Soil Gas Samples - Site Wide Locations (8-10' and 19-20' depths) - Highest concentrations were located in Building 40A, the east side of Building 40B, and the west side of the Maxwell Complex excavation area (adjacent to Building 40B).

- Groundwater Headspace and Groundwater Samples - Site Wide Locations (24-25' and 30-31' depths - Highest readings in the groundwater headspace samples were located in Buildings 40A, the east side of Building 40B, and the west side of the Maxwell Complex excavation area. Groundwater sample concentrations were highest on the west side of the Maxwell Complex excavation area, the west side of Building 40, at isolated outside locations south of Building 3A, east of Building 50, and south of

Building 53. The area outside Building 53 is the present location of the 1,1,1-trichloroethane storage tanks which are scheduled to be taken out of service in 1994. Selected groundwater samples at 30 - 31 foot depths were consistent with 24 - 25 foot depth readings with the exception of the sample taken south of Building 40B which showed an increase in magnitude at the 24 - 25 foot depths.

1,1,1-Trichloroethane (TCA)

- Soil Gas Samples - Buildings 40A and 40B (0-1', 3-4', and 6-7' depths) - Concentrations at each depth appeared to be highest near the 1,1,1-trichloroethane degreaser station and former CFC-113 degreaser station along the east side of the building. The CFC-113 degreaser was taken out of service in 1991 The TCA degreaser is scheduled to be removed from service in the first quarter of 1994 An aqueous based washer station is scheduled to replace it

- Soil Gas Samples - Site Wide Locations (8-10' and 19-20' depths) - Highest concentrations were found in samples taken along the western section of the Maxwell Complex, the eastern section of Building 40B (near the former location of the freon degreaser station), the western section of Building 40A, and the south end of Building 53 (the location of TCA storage tanks) The TCA storage tanks are scheduled to be taken out of service in 1994

- Groundwater Headspace and Groundwater Samples - Site Wide Locations (24-25' depths) - Groundwater headspace and groundwater samples at 25 foot depths found relatively higher concentrations in the same locations as the soil gas samples at 8 - 10 foot and 19 - 20 foot depths The groundwater samples taken at 30 - 31 foot depth also yielded similar results There were other isolated locations where relatively elevated groundwater concentrations of TCA were detected

Tetrachloroethene (PCE)

- Soil Gas Samples - Building 40A and 40B (0-1', 3-4', and 6-7' depths) - Concentrations appeared to be highest in the center section of the Buildings 40A and 40B. The Burlington site assessment reports that a former process unit consisted of a parts degreaser was located in this general vicinity but was removed from service in 1982.

- Soil Gas Samples - Site Wide Locations (8-10' and 19-20' depths) - Concentrations were highest south of Building 53 (near the TCA storage tanks), the eastern section of Building 40B (near the location of the former CFC-113 degreaser station) and the western section of Building 40A

- Groundwater Headspace and Groundwater Samples - Selected Site Wide Locations (24-25' and 30-31' depths) - Concentrations were highest in the same locations as the soil gas samples take at 8 - 10 foot and 19 - 20 foot depths Groundwater concentrations were also relatively higher at sample locations east of Building 50 and along the eastern boundary of the site. There were other isolated locations with elevated groundwater concentrations of PCE

1,1-Dichloroethene

- Soil Gas Samples - Buildings 40A and 40B (0-1', 3-4', and 6-7' depths) - Concentrations appeared to be relatively higher in the eastern section of Building 40B However, at depths below 3 - 4 feet, concentrations were elevated along the west side of Building 40A. Burlington noted a possible problem with the identification and reliable measurement of 1,1-dichloroethene due to lab instrumentation/calibration problems

- Soil Gas Samples - Site Wide Locations (8-10' and 19-20' depths) - Concentrations were relatively higher along the western section of the Maxwell Complex, the eastern section of Building 40B (near the former CFC-113 degreaser), and the western section of Building 40A.

- Groundwater Headspace and Groundwater Samples - Site Wide Locations (24-25' and 30-31' depths) - Groundwater headspace concentrations were relatively higher at the same locations as the soil gas samples taken at 8 - 10 foot and 19 - 20 foot depths and south of Building 53 Groundwater sample concentrations were elevated at locations south of Building 53 (in the general vicinity of the TCA storage tanks scheduled to be removed from service in 1994). The Soil Gas Investigation report noted the discrepancy of high concentrations of 1,1-dichloroethene observed by laboratory results but not observed during field testing.

cis-1,2-Dichloroethene

- Soil Gas Samples - Buildings 40A and 40B (0-1', 3-4', and 6-7' depths) - Concentrations appeared to be relatively higher along the east side of Building 40B (near the location of the former CFC-113 degreaser station) and center of the building (in the general vicinity of the parts degreaser taken out of service in 1982)

- Soil Gas Samples - Site Wide Locations (8-10' and 19-20' depths) - Concentrations were relatively higher along the western section of the Maxwell Complex, the east section of Building 40B, and east of Building 50

- Groundwater Headspace and Groundwater Samples - Site Wide Locations (24-25' and 30-31' depths) - Groundwater headspace concentrations were relatively higher at the same locations as soil gas samples taken at 8 to 10 foot and 19 to 20 foot depths. Groundwater samples were non-detect

trans-1,2-Dichloroethene

- Soil Gas Samples - Buildings 40A and 40B (0-1', 3-4', and 6-7' depths) - Soil gas samples were non-detect.

- Soil Gas Samples - Site Wide Locations (8-10' and 19-20' depths) - Samples were not taken.

- Groundwater Headspace and Groundwater Samples - Site Wide Locations (24-25' and 30-31' depths) - Groundwater samples results were relatively higher in the western section of the Maxwell Complex.

1,1,2-Trichloroethane (Groundwater samples only): Sample results were relatively high in the western section of the former Maxwell Complex Concentrations were much lower in the Maxwell Complex, south of Building 53, and in the southeast property corner

1,1-Dichloroethane (Groundwater samples only)· Groundwater sample results were relatively higher in the western section of the Maxwell Complex, south of Building 53 (current location of TCA tanks), and along the southeast corner of the property

1,2-Dichloroethane (Groundwater samples only) Groundwater sample results were relatively higher in the western section of the Maxwell Complex, and south of Building 53 (near the current location of the TCA storage tanks)

In summary, solvents were found in the soil under Buildings 40A and 40B, the south western portion of the former Maxwell Complex, in the storage area east of Building 50, and south of Building 53 near the TCA tanks

### 2.4 Soil Remediation Program

As a result of the investigation, four stock piles were created with the soil removed from the footprint of Building 59 The soils were treated as follows:

- A stockpile of clean soil was relocated to a parking lot in the northeast portion of the property
- A stockpile was constructed north of Building 47 to treat soil primarily impacted with total petroleum hydrocarbons (TPH)
- Another stockpile was located in the same vicinity of soils that were primarily impacted by volatile organics (VOCs)
- Another stockpile was located southeast of the petroleum pile of soil which was impacted by a variety of compounds.

The VOC and TPH piles were treated by vacuum extraction Two blowers were installed in each pile and were connected by manifolds to the piping at the base of the bed The VOC pile was cleaned by this process The TPH soils have since been combined with the unknown pile and are now undergoing biotreatment.

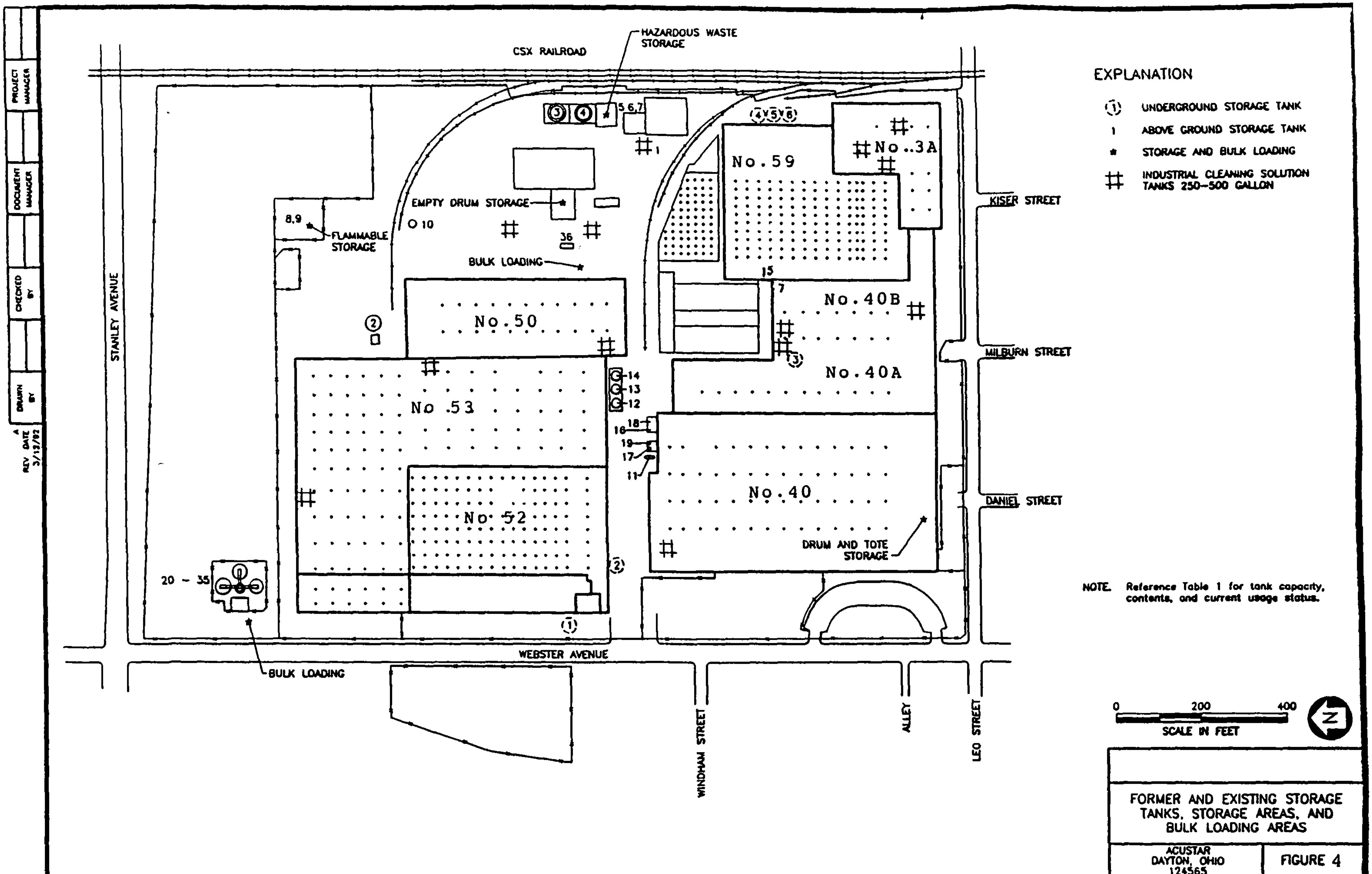
## SECTION 3.0 - POTENTIAL ENVIRONMENTAL IMPACTS

This section of the report will summarize the potential on-site sources identified in the Burlington report (Environmental Site Assessment - March, 1992) and provide an update on the status of these sources. In addition, various potential off-site sources were evaluated and our findings are presented herein.

### 3.1 On-Site Potential Sources

The various activities at the plant which may have impacted the soil or groundwater were reviewed. These sources include underground and above ground storage tanks, chemical storage areas, hazardous waste accumulation storage areas, sumps for waste oil or process wastewater, past spills, and various processes or operations of the plant. These potential on-site sources of contamination were identified in the above referenced report prepared by Mathes/Burlington (see Figure 4) In summary the following was identified.

- There were 36 above ground storage tanks noted in the report. The tanks store a variety of materials including. fuels, acids, polymers, oils, and solvents The tanks which store TCA and its sludge are located on the south side of Building 53 and the north side of Building 40.
- There were 6 underground storage tanks (USTs) on-site, 3 gasoline and 3 fuel oil. Of these, 1 gasoline and 2 fuel oil USTs were properly abandoned. The 2 remaining gasoline USTs were removed in July, 1993 under State supervision and the area surrounding the tanks was declared clean The other fuel oil tank was accidentally discovered during excavation activities associated with the Maxwell Complex demolition This 500 gallon tank was subsequently removed by Mathes/Burlington and surrounding soils were treated to ensure the soil was clean There is no knowledge of any remaining USTs on the DTPP site
- There are 4 hazardous waste streams generated by the plant They are




FORMER AND EXISTING STORAGE TANKS, STORAGE AREAS, AND BULK LOADING AREAS

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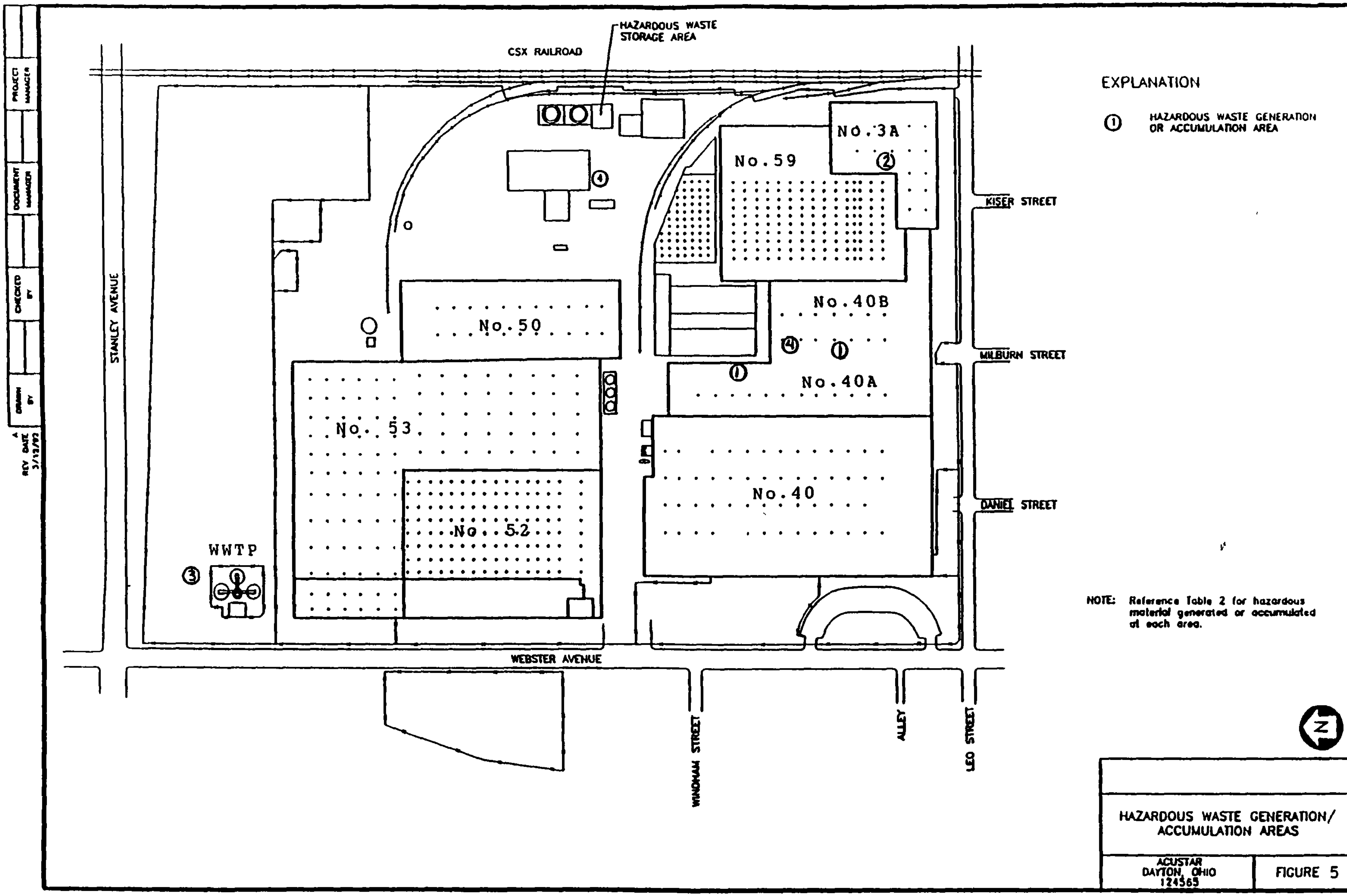
FIGURE 4

1. The combined degreaser sludges from the CFC-113 and TCA operations.
2. Maintenance-derived paint waste containing isopropyl alcohol
3. Waste water treatment plant sludge.
4. Magnesium-containing waste.

(See Figure 5 for hazardous waste generation and accumulation areas.)

- An in-house program is underway to reline and/or recoat the sumps. A majority are now complete. Sumps are now being capped.
- Process areas were also investigated. Figure 7 of the Burlington report identifies those areas that contain processes of concern. A listing of process areas of concern in the Burlington report has been updated since DTPP has undertaken a program to remove and replace those processes using regulated substances There are currently three chlorinated solvent degreasers in the plant, two in the production area and one small unit in a lab A TCA degreaser is located in the NE area of Building 40A and is scheduled for replacement with an aqueous washer and removal in early 1994 A CFC-113 degreaser is located in the middle of Building 40A and is scheduled for replacement in mid-1994 and will be replaced by a vacuum de-oiling system A small CFC-113 engineering laboratory degreaser will be replaced and removed as soon as a suitable alternative can be found.
- Clean Tech reviewed spill records maintained by DTPP from mid-1988 through mid-1993. The records included internal documentation on spills that required notification of State and Federal agencies Of the 36 spill records reviewed, 25 percent were attributed to machine or hydraulic oil products. Locations included the area south of the non-hazardous storage area, and Buildings 6, 39A, 3A, 53, and the former Maxwell Complex Quantities released did not typically exceed fifty gallons and ranged from 0 5 - 300 gallons These surface spills typically involved waste oil sumps and/or the storm sewer system. Spills included




HAZARDOUS WASTE GENERATION/ ACCUMULATION AREAS

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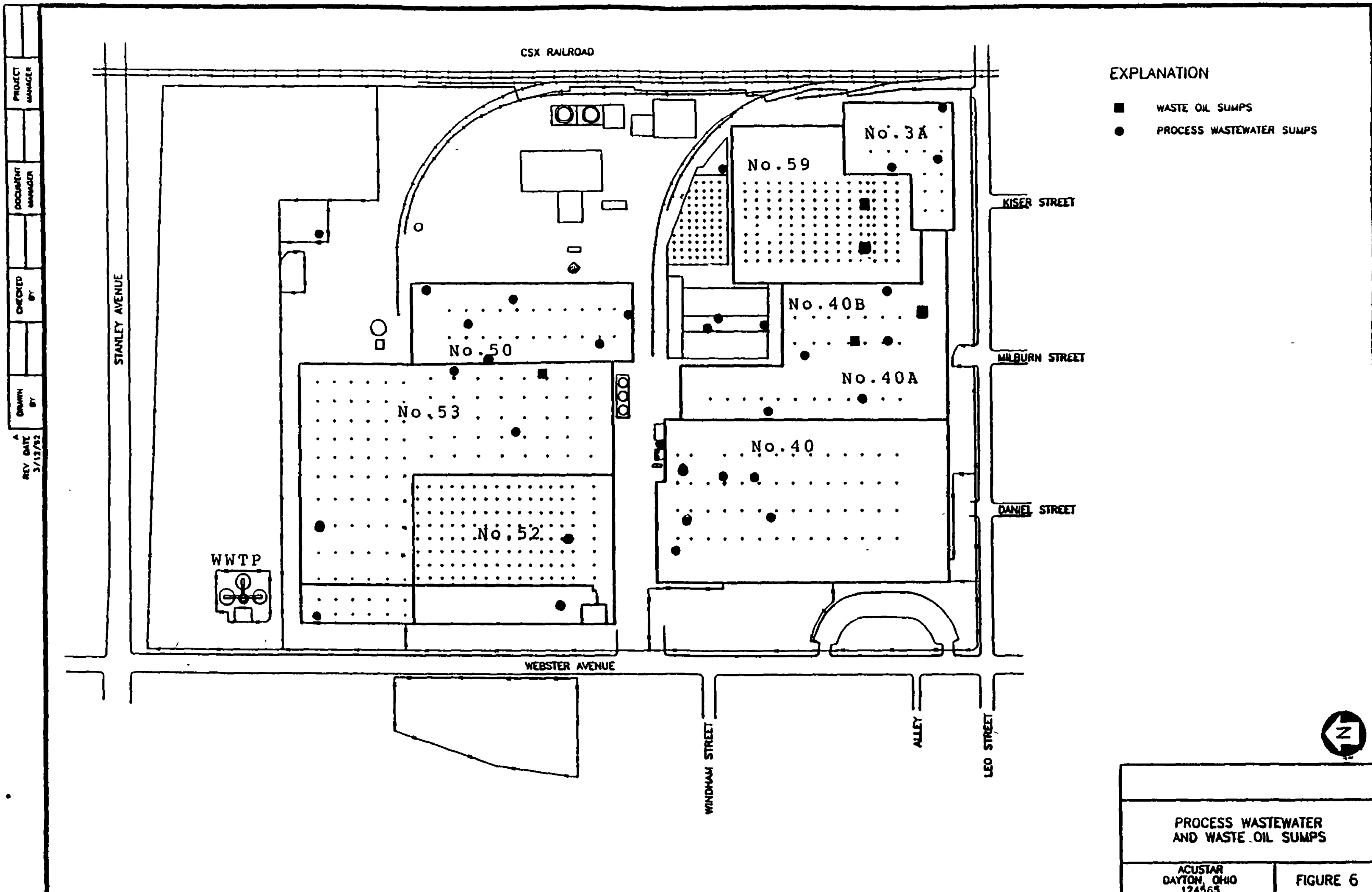
FIGURE 5




PROCESS WASTEWATER AND WASTE OIL SUMPS

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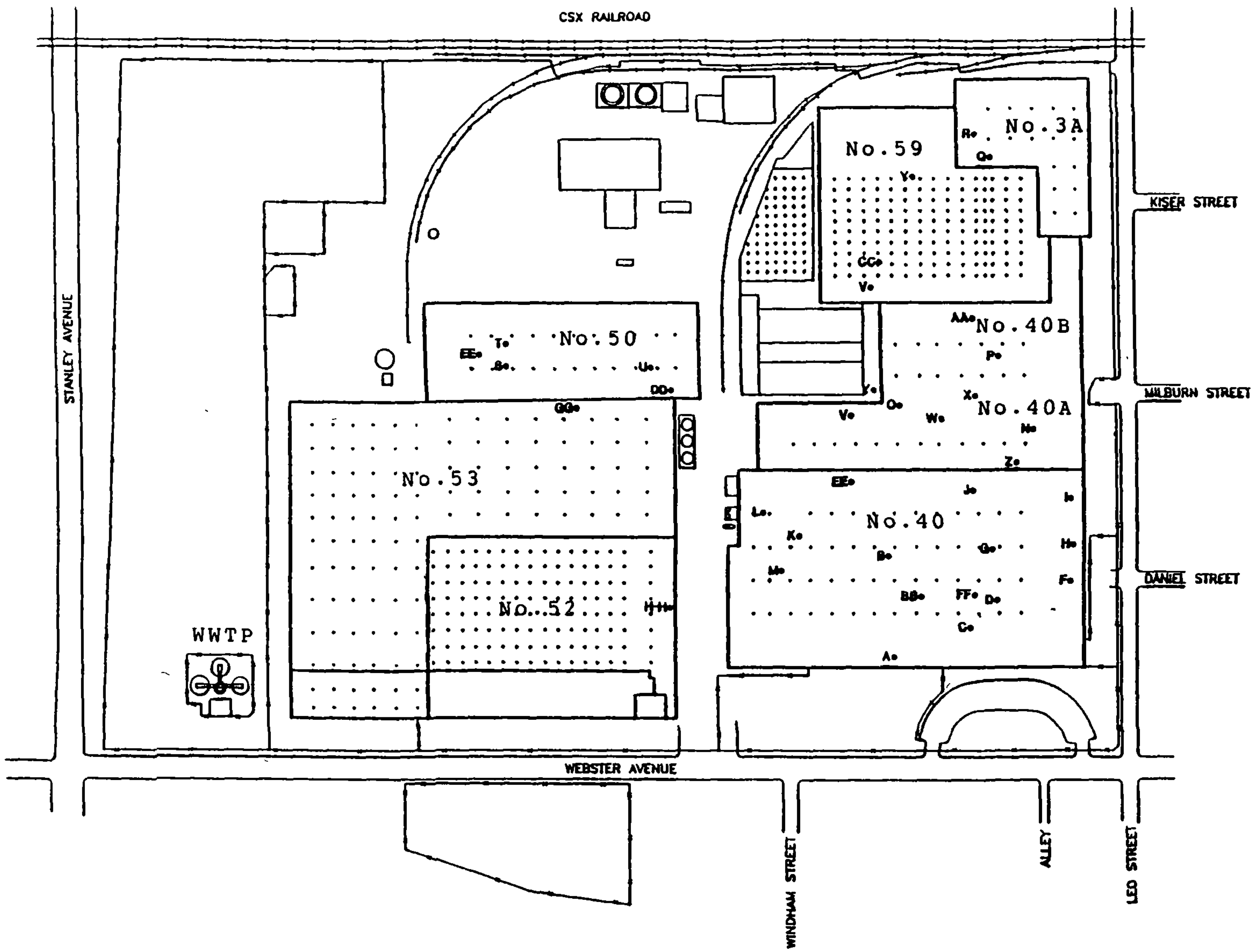
FIGURE 6




EXPLANATION

H• PROCESS UNIT AND LOCATION

A. First Impregnation, Loctite System
B. Shaft Assembly, Washer Dept 9295
C. West Coolant Pit
D. Cargill Washer
E. Piston Washer
F. South Shell Washer
G. East Coolant Pit
H. South Coolant Pit
I. Second Impregnation, Loctite System
J. North Coolant Pit
K. Shaft Washer, Dept. 9290
L. Clutch Retainer Washer
M. Steel Machining Coolant Pit
N. Phosphating Washer
O. Cleaner Tanks, Dept. 9221
P. Paint Booth
Q. Paint Booth
R. New Washer
S. Washer Tanks, Dept. 9227
T. Cleaner Tanks, Dept. 9227
U. Flush Washer System
V. Henpro Degreaser
W. Plate/Fin Evaporator Degreaser
X. Parts Degreaser (Removed in 1982)
Y. Plating Operation - Zinc Chromate
Z. Swashplate Heat Treatment Machine
AA. New Detrix Degreaser
BB. Compressor Parts Degreaser (Removed in 1976)
CC. Dip Tank (Removed in 1984)
DD. Degreaser (Removed in 1981)
EE. Detrex Degreaser (Removed in 1991)
FF. Freon Degreaser
GG. Xylol-based Paint Booth (Removed in 1981)
HH. Vapor Degreaser

PROCESS UNITS AND AREAS

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FIGURE 7

PROJECT MANAGER
DOCUMENT MANAGER
CHECKED BY
DRAWN BY
REV DATE
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1. About 500 gallons of chrome-containing paint sludge in Building 47, November, 1988.
2. About 12,000 gallons of zinc and chrome-containing process waste water in the NW corner of Building 53. A minimum of 7,000 was vacuumed-up in March, 1989.
3. Overfill of TCA storage tank (quantity unspecified), June, 1989
4. Chromium sludge discovered during demolition of Maxwell Complex in old, abandoned sewer leading to an oil-water separator east of Building 40B, November, 1990.
5. About 30 gallons of CFC-113 in empty drum storage area, November, 1990.
6. About 35 gallons of untreated waste water containing flux rinse water near Building 50, March, 1991.
7. About 150 gallons of water/sulfuric acid solution in Building 50 parts washer, January, 1992.
8. Unspecified quantity of TCA from storage tank next to Building 53, May, 1992.
9. Unspecified quantity of Alcoat 300B, conversion coating accelerator, in containment area of Building 40A, February, 1992

### 3.2 Off-Site Potential Sources

A survey of potential off-site sources of regulated compounds was conducted using zip code areas. A survey of the EPA and Ohio EPA databases (1991) was previously completed using the Zip Code of 45414 Identified sites were listed in Appendix A of the Burlington Site Assessment report and were depicted in Plate 1 of that report These records were again reviewed and it was determined that the following facilities were within an about two mile radius or less to the plant. These include, according to our search.

EPA Sites

- Gem City Chemicals, Inc

CERCLIS Sites

- Montgomery County North Incineration

Ohio EPA did not have any records for American Lubricants Company, Montgomery County North Incinerator, Ris Paper Company, Gem City Stamping, Inc., and Brainerd Industries. Hohman Plating and Manufacturing and Angell Manufacturing Company information consisted of contingency plans, RCRA inspections and records of personnel right-to-know training. There have been no site investigations or remediation projects at any of these sites according to State of Ohio EPA records. The most extensive records obtained for remediation activities were for Gem City Chemicals Inc. and DAP, Inc.

DAP Inc. is located at 220 Janney Road in Dayton, Ohio DAP Inc is involved primarily in the manufacture of adhesive products A 1988 site assessment report was prepared by Applied Geotechnology, Inc. The facility began operation in the early 1960s and has been involved in the manufacture of caulking, glazing, and adhesive compounds The property covers about 6 acres and includes a manufacturing and warehouse building, several underground storage tanks, outside storage, parking lots, and undeveloped open areas.

Based on historic information there are several in-plant tanks used to store materials including methyl ethyl ketone (MEK), methylene chloride, TCA, latex, paragon-500, sodium silicate, NF Brush (2000), and Tergital NP-10 Materials stored in the USTs include various halogenated and non-halogenated volatile organic solvents, toluene/lactol blend, MEK, mineral spirits, naphtha, acetone, negaloid toluene, and TCA.

Soil samples have been taken at various locations on the property including the underground storage tank area and the undeveloped area north of the manufacturing building The samples were tested for TPH and VOCs About one-third of the samples contained TPH concentrations above detection limits, 9 samples contained greater than 50 mg/kg and 1 sample contained greater than 100 mg/kg. Approximately one-fourth of the samples had detectable concentrations of the

Target Compound List (TCL) VOCs. The most frequently detected VOCs was TCA, with 24 samples above detection limits (averaging from 0 120 - 5 19 mg/kg). Other VOCs detected included carbon tetrachloride, 1,1-dichloroethane, 1,2-dichloroethane, and toluene.

Gem City Chemicals, Inc. is located at 1287 Air City Avenue in Dayton, Ohio. Gem City Chemicals operations are primarily blending and distribution of chemicals. The plant occupies about 7 acres and is located about 200 yards east of the DTPP property boundaries. The B&O Railroad line separates the two sites. According to the July, 1993 revision of the site assessment report prepared for Gem City Chemicals, Inc by Q-Source Environmental Services, Inc. and on file with the State of Ohio EPA, the plant has operated at the site since 1969

Typical operations include the purchases of various chemical products in truck load quantities, the repackaging of chemicals into smaller containers, drums and tote tanks, and the resale of these smaller quantities of chemicals to industrial customers. Both liquid and solid chemicals are handled and include acids, solvents (including but not limited to toluene, xylene, freons, TCA, ethyl acetate, MEK, TCE, acetone, and naphtha), and other miscellaneous chemicals

Site assessments were conducted in 1987 and 1988 at Gem City Initial sampling included soil sampling at 12 locations in June, 1987, a soil gas survey at 40 locations in July, 1988, and groundwater sampling from 10 monitoring wells constructed in 1988 Soil sample tests at several locations detected 10 organic chemicals including methylene chloride, PCE, TCE, TCA, methyl alcohol, isopropyl alcohol, acetone, toluene, xylene, and MEK Soil gas survey results detected TCE, PCE, and TCA at a number of locations including samples taken near the B&O Railroad tracks to which the DTPP is contiguous Groundwater monitoring well analysis was completed on a regular basis from 1988 - 1993 and the following has been detected acetone, benzene, chloroform, 1,1,1-dichloroethane, 1,2-dichloroethane, 1,1-dichloroethene, cis-1,2-dichloroethene, trans 1,2-dichloroethene, ethylbenzene, hexachlorobutane, PCE, toluene, 1,2,3-trichlorobenzene, 1,2,4-trichlorobenzene, TCA, TCE, and vinyl chloride

Gem City Chemicals remediation project is ongoing and includes an air stripper system, groundwater recovery wells which were installed in 1987, and a soil vapor extraction system consisting of five soil vapor extraction wells. The soil vapor extraction system was shut down in 1991 and restarted for a brief period of time in 1992. Since no significant concentration of VOCs (≤5 ppm) were detected, the vacuum extraction wells were abandoned with removal of the blowers and filling the wells with grout.

### 3.3 DTPP Site Summary

Soils:

The results of the investigation by Burlington indicated the soils were impacted by organics These include primarily TCE, TCA, PCE and some heavy metal contamination (chromium and lead). Based on soil gas results, the areas which may have been impacted by plant operations or other sources include.

- Building 40B in the area which contained the former CFC-113 degreaser station.
- South side of Building 53 which contains the TCA storage tanks
- Buildings 40A and 40B which contained former parts degreasers
- West and southwest section of the former Maxwell Complex or present Building 59
- Storage areas located east of Building 50

Groundwater

To summarize groundwater quality, there are 3 process cooling water wells on-site Well 1, located in Building 40, has been abandoned Well 2 is in the boiler house and is about 80 feet deep Well 3 is east of Building 50 and is about 135 feet deep

The wells were sampled by the State and DTPP several times between November 1989 and July 1990 The analytical results indicate that Well 2 contains the following

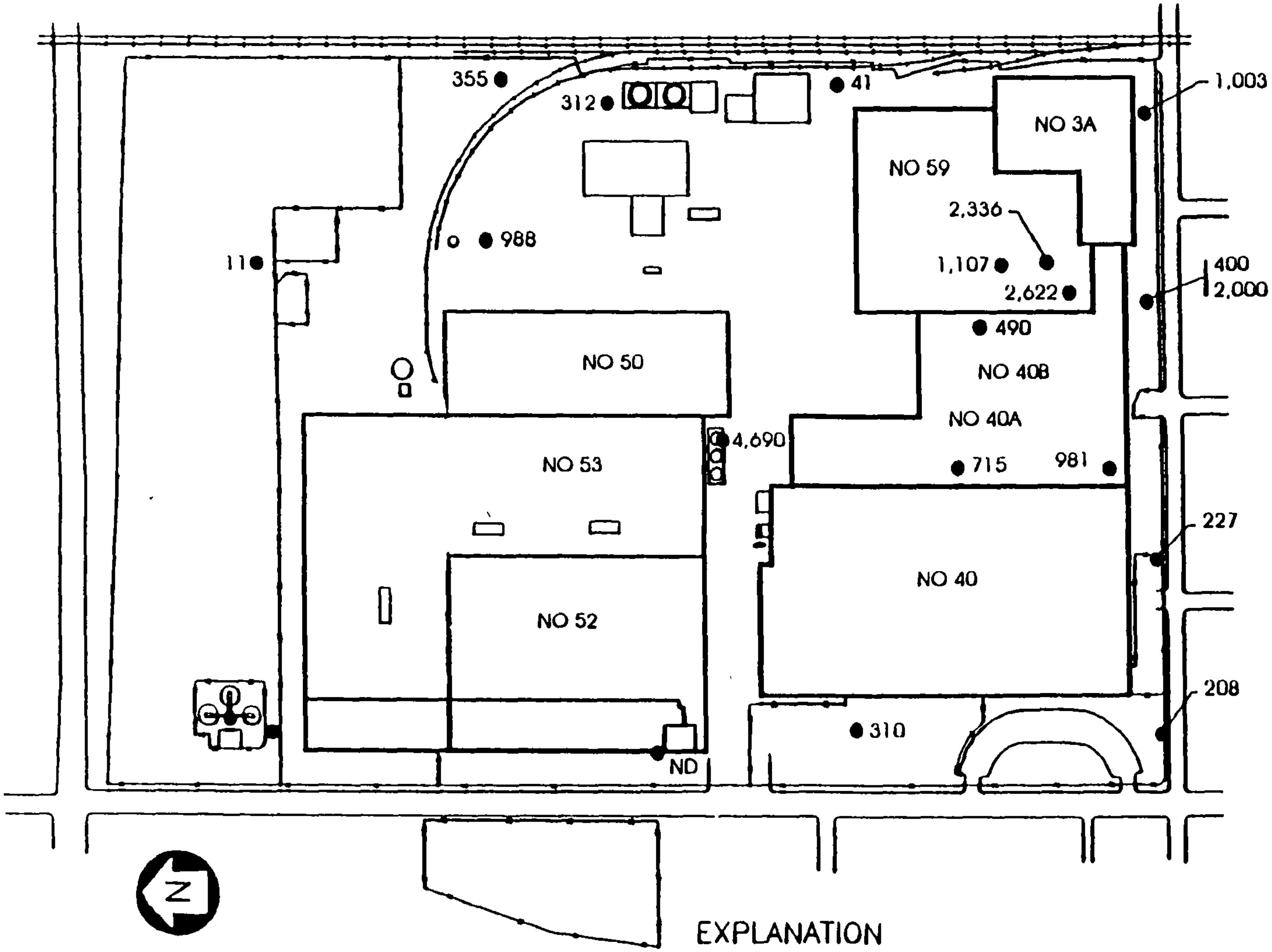
- 1,1-Dichloroethane
- 1,1-Dichloroethene
- Trans-1,2-Dichloroethene
- Tetrachloroethene
- 1,1,1-Trichloroethane
- Trichloroethene
- Vinyl Chloride

Well 2 contained no regulated compounds Additional groundwater samples were taken at the time soil gas was completed The samples were drawn through the soil gas probe and should not be considered representative samples. Figure 8 shows total VOCs found at that time The results indicated that groundwater may have been impacted near Buildings 40A, 40B, 59, and 53 More definitive groundwater studies should be completed.

In summary, past plant activities may have impacted the soil and groundwater at the site Due to the age of the plant and past plant uses (especially the Maxwell Complex, circa 1907), the variety of products manufactured over the years, much of the former history at the plant is not known. As stated in Section 2, most of the chlorinated solvent degreasing operations have been removed and/or replaced The present and last TCA degreaser in Building 40A is scheduled for replacement with an aqueous washer in early 1994 The associated storage tanks outside Building 53 are also scheduled for removal in 1994 The CFC-113 degreaser in Building 40A is scheduled for replacement with a vacuum de-oiler with removal in mid-1994 The small CFC-113 engineering lab degreaser will be replaced as soon as an acceptable alternative is found, most probably in mid-1994

FIGURE 8

# TOTAL VOCs IN GROUNDWATER
# DAYTON THERMAL PRODUCTS PLANT




EXPLANATION

● 310 APPROXIMATE RECON™ PROBE HOLE LOCATION
TOTAL VOC CONCENTRATION IN GROUNDWATER (ug/L)

ND NOT DETECTED

Prior to considering further remediation, additional investigations must be performed to more fully characterize the site. In addition, it is possible that DTPP may have been impacted by two nearby facilities. They are DAP and Gem City Chemicals, Inc. A better understanding of the DTPP site will be possible after groundwater quality and direction are determined.

### 4.1 Regional Geomorphology

The Dayton area is located in the central lowland and physiographic province which is primarily drained by the Miami River and its tributaries (USGS-1966) The Dayton plant is located on a flat topped terrace which is an erosional remnant from the outwash of the Mad River (see Figure 9). This glacial outwash gravel unit stretches northward to Urbana and southward to the Miami River. The surface materials of these types of outwashes consist of coarse sand and gravel, although other sediment types may be present. In some areas of the Mad River outwash, windblow losses which contains silt has been noted. The terrace is bordered on the north, west, and south by the flood plains of the Miami and Mad Rivers Flood plain sediments are about 20 feet thick. The top of the moraine is present north-east of the site in Mad River Township. The moraine was mapped as a thin to thick layer of till overlaying sand and gravel by Goldthwait (Norris, Cross, Goldthwait, 1948) and by Forsyth (Norris & Spiker, 1966)

### 4.2 Regional Stratigraphic Units

There have been regional studies completed by Norris & Spiker (1966) which confirm that the uppermost unconsolidated unit consists of an outwash deposit up to 80 feet thick The outwash deposit contains primarily sand and gravel. Discontinuous till lenses have been encountered in some wells in the vicinity of the Dayton site Published studies by Norris & Spiker (1966) indicate that the till layer may be discontinuous on a regional scale These reports suggest that at some locations the till is a thick massive unit while at other locations it has been logged as stratified with sand and gravel. The location of this till layer becomes important when attempting to determine the direction and rate of regional groundwater flow A continuous layer of till was noted in the geologic cross-section of Gem City Chemicals which borders DTPP along Air street. The layer was observed from 80 - 100 feet below grade


## Well Yields

AREAS IN WHICH YIELDS OF MORE THAN 500 ... OR MORE GALLONS PER MINUTE MAY BE DEVELOPED

Permeable sand and gravel deposits beneath the floodplain of the Mad and Miami Rivers. Properly constructed large diameter ... wells yield in excess of ... gallons per minute at depths ranging from ... feet to as much as 135 feet.

AREAS IN WHICH YIELDS OF 100 TO ... GALLONS PER MINUTE MAY BE DEVELOPED

Regionally extensive thick permeable deposits of sand and gravel may yield as much as 500 gallons per minute. Extensive ... drilling is recommended to locate coarse deposits at average depths of 75 feet ... ranging from ... to as much as ... feet.

AREAS IN WHICH YIELDS ... MAY BE DEVELOPED

Water-bearing deposits of sand and sand and gravel interbedded with thick layers of clayey till ... deposits may be ... developed at average ...

AREAS IN WHICH YIELDS OF 5 TO 20 GALLONS PER MINUTE MAY BE DEVELOPED

Ground water obtained from thin, not extensive, sand and gravel deposits interbedded with relatively thick layers of clayey till. Wells are usually developed at depths of less than 135 feet and deeper drilling into the underlying bedrock may be non-productive.

AREAS IN WHICH YIELDS OF 3 TO 10 GALLONS PER MINUTE MAY BE DEVELOPED

Average yields for wells developed in basal Silurian limestone bedrock ranges from 4 to 6 gallons per minute. Drilling deeper than 80 feet is not advisable owing to the presence of the non-water-bearing Ordovician shaly limestone bedrock. Cisterns and/or storage may be necessary for peak periods of water demand.

Relatively thick ... consolidated glacial deposits of silty sand and clayey till. Thin layers of water-bearing sand and gravel may be encountered at depths ranging from ... more than 60 feet ... drilling advisable to attempt the development ... relatively deeper zones.

AREAS IN WHICH ... GALLONS PER MINUTE MAY BE DEVELOPED

Clayey till ... water ... shaly limestone ... developed ... water ...

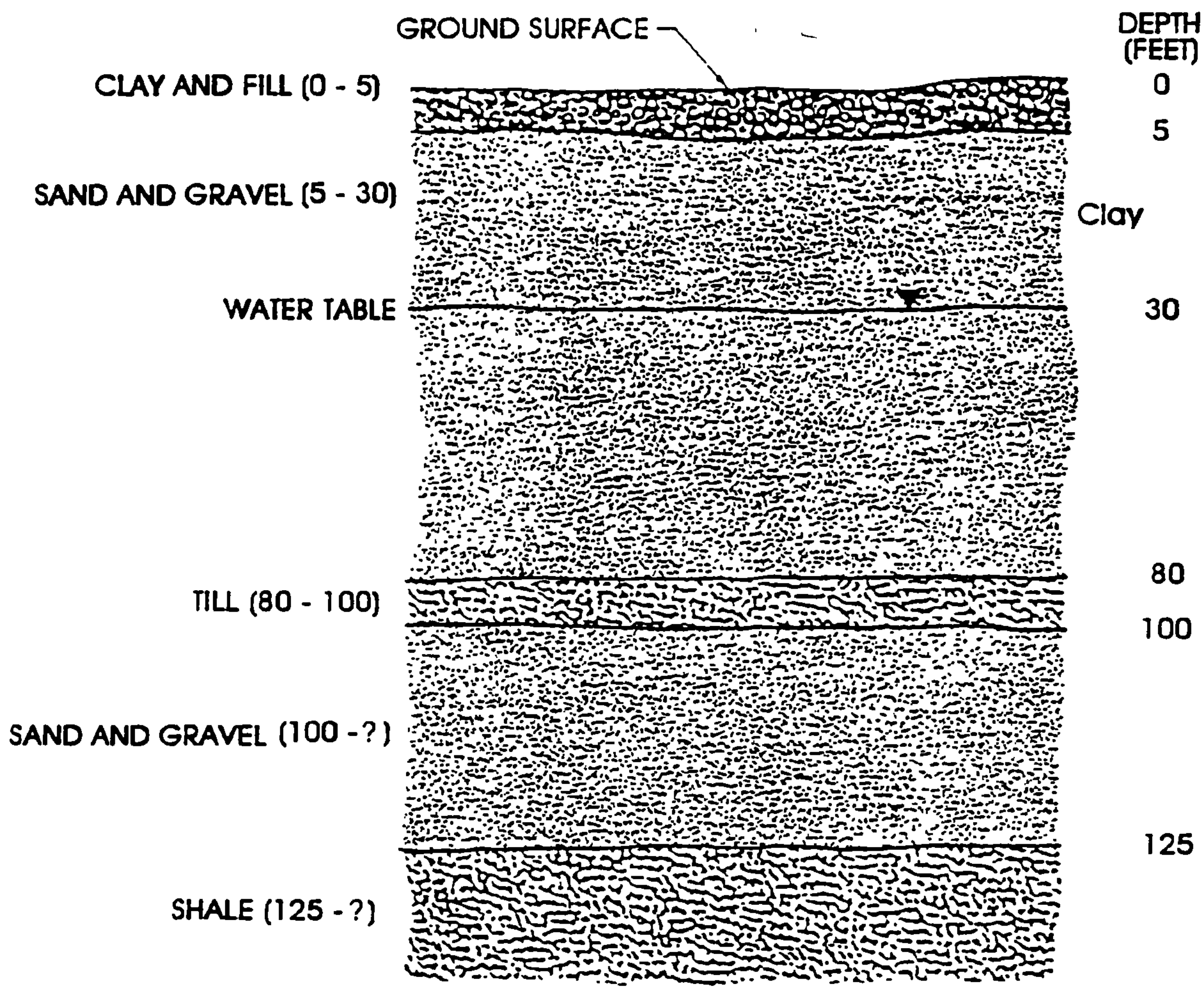
A second aquifer unit was noted under the till in regional studies. The till layer is composed of fine to medium sand, sand and gravel and fine to coarse gravel (NEARBI Site Investigation). Gem City Chemicals, Inc. has drilled a total of twenty-four test borings throughout their facility Boring logs are contained in the Site Assessment Report prepared by Q-Source Environmental Services, Inc. dated July 28, 1993. The logs suggest that the surface material at the site is about 80 - 90 feet thick. Surface materials consist of coarse to fine sand and gravel. Below this surface material is a continuous layer of dense till consisting primarily of silt. A thin clay or silt layer was also encountered near the surface at a depth of about 15 feet. Based on these borings for Gem City Chemicals, the following was noted.

- The surface materials consist of a thin disturbed layer of fine-grained loess, coal fragments, and fill material.
- The next layer consists of a sand and gravel deposit The material contains medium to coarse sand and small pebbles with interstitial fine sands and silt. The thickness of this layer is about 20 feet.
- Another layer of fine sand or silt was encountered at 20 feet This silty-clay layer was observed in the test borings and in monitoring wells known as the MW-5 cluster and RW-1. It varies in thickness from 6 inches to 2 feet
- The next well defined unit from about 20 feet to the bottom of the uppermost aquifer consists of outwash deposit material This is composed of interbedded coarse sand to granules with traces of pebbles and silt.
- At a depth of 82 feet a dense layer of silt was encountered (Boring P-4). This unit consists of dark gray silt, with fine to coarse sand and trace pebbles

The information prepared for Gem City is in agreement with other regional reports on the stratigraphy of the area (See Figure 10 for conceptual stratigraphy for DTPP )

FIGURE 10

# CONCEPTUAL STRATIGRAPHY
# DAYTON THERMAL PRODUCTS PLANT



### 4.3 Site Hydrology

Several reports were evaluated to determine the regional as well as local direction of groundwater flow. Reports by Norris & Spiker and $CH_2M$ Hill established that regional flow was towards the southwest, parallel to the Miami South Wellfield.

According to other published reports, flow direction has changed to the north following the installation of the City of Dayton's Miami South Well Field in the early 1960's. The groundwater flow divide originally located north of Gem City Chemical has shifted to the south. This has changed groundwater flow at the plant to the north-east. The gradient across Gem City Chemical is flat and any changes or alterations to the pumping of the Miami South Well Field will likely alter the flow of groundwater. Also, another factor which may shift groundwater flow direction is the amount of recharge to the aquifer. Measurements taken at Gem City Chemical indicate that the elevation of the groundwater to the surface has varied by about 12 feet reaching a high of 730 MSL in 1991 and a low of slightly over 718 feet in February, 1992 This is a result of a normal water cycle in which there is a rising groundwater table during the winter and spring and a falling groundwater table during the summer and fall A review of the potentiometric surface measurements however indicated that at the Gem City Chemical site, variations in recharge do not appear to affect the general direction of groundwater flow It has been shown, however, to affect the overall elevation of the groundwater table and the associated saturated thickness of the aquifer.

At the Gem City Chemical site one of the most important factors affecting groundwater movement is the presence of a recovery well system in the center of the site which pumps at approximately 300 gallons per minute (gpm) This recovery well has created a cone of depression at the Gem City Chemical site (see Figure 11)

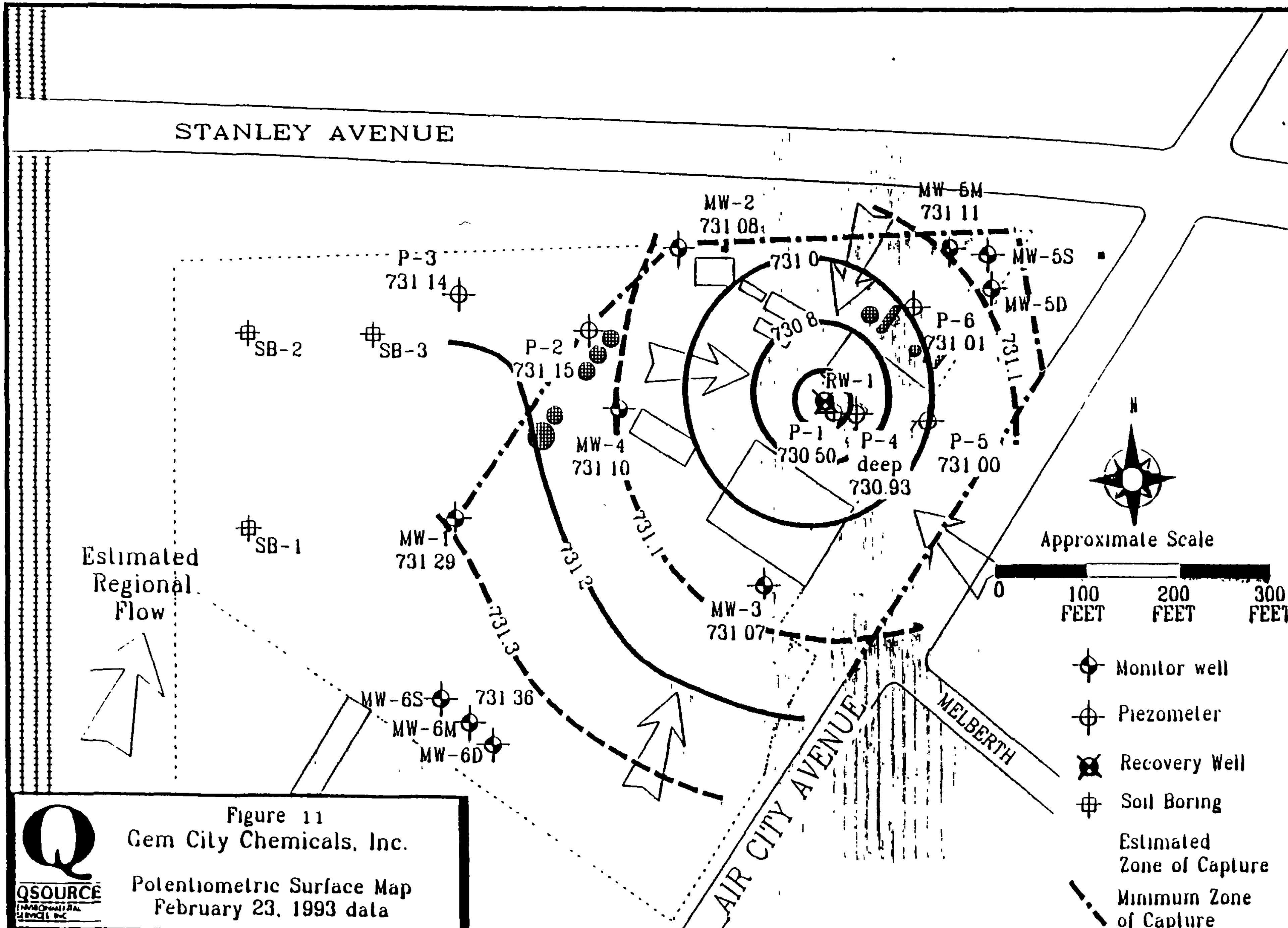



Figure 11
Gem City Chemicals, Inc.

Potentiometric Surface Map
February 23, 1993 data

### 4.4 Aquifer Characteristics

The hydraulic conductivity of the shallow aquifer is approximately 200 feet per day. Using an estimated saturated thickness of the shallow aquifer of 30 to 80 feet, the transmissivity of the aquifer is approximately 15,00 to 40,000 square feet per day (Q-Source -1989).

Studies completed by Dames & Moore in 1991 for the DAP site which is located about 4 miles north of this site, included an aquifer recovery test which monitored drawdown in the monitoring wells and piezometers surrounding the pumping well. Transmissivity values were calculated from the recovery results and were in the range of 249,000 gallons per day per foot to 747,000 gallons per day per foot. The transmissivity appears to generally be lowest in the shallow part of the aquifer and it increases with depth.

The lithology of the deep aquifer is very similar to the shallow aquifer. Based on reports prepared for Gem City Chemicals, it appears to be irregular The saturated thickness of the deep aquifer is approximately 60 feet thick.

The deep aquifer contains a significant amount of silt which has impacted its hydraulic conductivity Groundwater in the deep aquifer is under semi-confined conditions Hydraulic conductivity values for the deep aquifer range from 140 - 200 feet per day Reported transmissivity ranges from 1,200 - 12,000 square feet per day A storage coefficient of 0.001 is within the expected range for a confined aquifer.

Values for the aquifer parameters developed by $CH_2M$ Hill in 1972 for the development of the Miami South Well Field were.

<u>Upper Aquifer</u>

Hydraulic Conductivity - 0 003 ft/sec (260 ft/day, 2021 GPD/ft$^2$)

| | | |
|---|---|---|
| Storativity | - | 0 2 ft/ft |

Till Layers

| | | |
|---|---|---|
| Hydraulic Conductivity | - | 0.44 x $10^{-6}$ ft/sec (0.04 ft/day, 0.3 GPD/ft²) |
| Storativity | - | 0 ft/ft |

Lower Aquifer

| | | |
|---|---|---|
| Hydraulic Conductivity | - | 0.001 ft/sec (87 ft/day, 710 GPD/ft²) |
| Storativity | - | 0 00001 ft/ft |

This model assumed a 50 foot thick saturated zone in the upper aquifer, and variable thicknesses for the till and lower aquifer. The transmissivity values were not calculated directly All values were calculated assuming that each of the layers within the model are homogeneous and isotropic. Due to the directions of flow that are calculated from this model, the calculated hydraulic conductivities are likely to reflect the horizontal conductivity in the "upper" and "lower" aquifers, and the vertical conductivity through the till Considerable local variability from these values is likely across the region.

During the pump test conducted at Gem City Chemicals, Inc on February 21, 1990, the recovery well was pumped at a rate of 340 GPM and the water level in the piezometer installed 3 5 feet away from the pumping well was monitored. The drawdown was 0 75 feet after 450 minutes of pumping. This gives a value for transmissivity of 52,900 square feet per day or 395,000 gallons per day per feet and conductivity of 0 226 centimeters per second (755 ft/day) This value is about three times the average value calculated from the model studies The effective porosity of the silty sands and gravels found in the Dayton area is estimated to be 20 percent The storativity is estimated to be 0 10 to 0 20, based on the estimated effective porosity

Based on these values, the pre-pumping groundwater flow velocity is estimated to be about 1 2 feet per day. The current flow velocity in the area surrounding the pumping well is estimated to be 6 4 feet per day The potentiometric surface elevations have been measured in the two well clusters located at the northeast and southwestern limits of Gem City Chemicals, Inc. The levels measured in the three wells in each cluster are similar, which indicated that the groundwater flow is nearly level at both locations.

Due to the presence of the till layer separating the valley fill deposits into "upper" and "lower" aquifer systems, the direction of groundwater flow was evaluated separately at Gem City Chemicals for each of the two layers As described previously, a low-permeability till layer is present beneath Gem City Chemicals, Inc and for at least one-half mile surrounding the site This till layer effectively isolates the uppermost, unconfined aquifer at Gem City Chemicals, Inc. from any deeper, confined aquifers that may be present.

Ground-water flow directions in the lower aquifer have changed considerably during the past thirty years, due to changes in water usage in the surrounding areas Potentiometric maps compiled by Norris & Spiker (1966) for 1959 and 1960 (prior to the time when the Miami South Wellfield began operations) show groundwater flow to the southwest, towards a wide cone of depression developed beneath the central business district of Dayton, and also towards industrial facility water supply wells to the southwest A major cone of depression had developed beneath the Miami South Wellfield following the beginning of production of water from the wellfield, in the early 1960's. Maps compiled by $CH_2M$ Hill for 1972 and for 1986 show this cone of depression The location of Gem City Chemicals, Inc appears to be on or near a divide between these two cones of depression, and the direction of groundwater flow at the site could be either to the north or to the south, or it could fluctuate depending on recharge variations and variability in the pumping rates at the city's wellfield

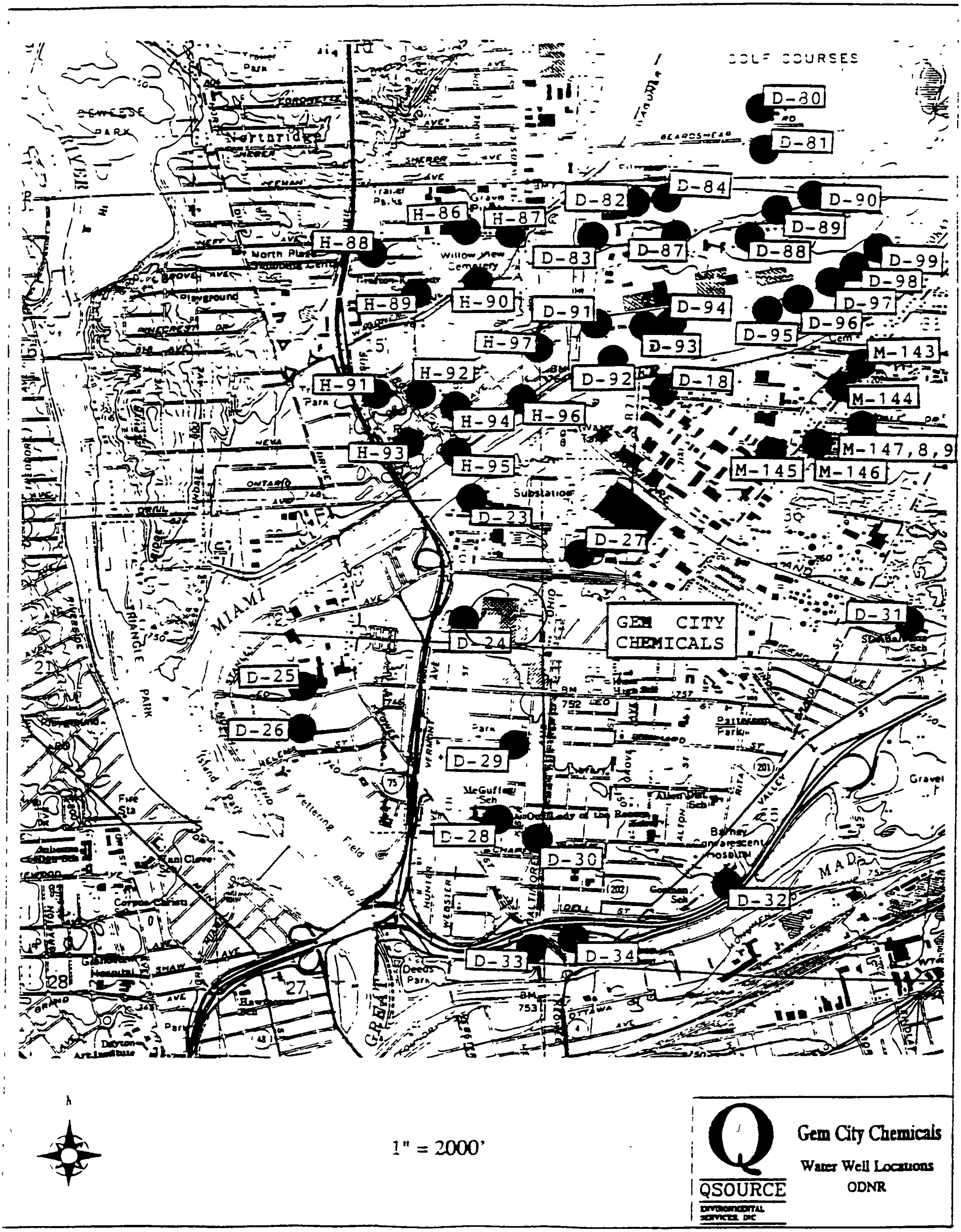
### 4.5 Local Groundwater Use

The most prominent local user of groundwater is the Miami River Well Field owned by the City of Dayton. It is located north of the Dayton plant across the Great Miami River. It contains 22 production wells (Geotrans, 1986).

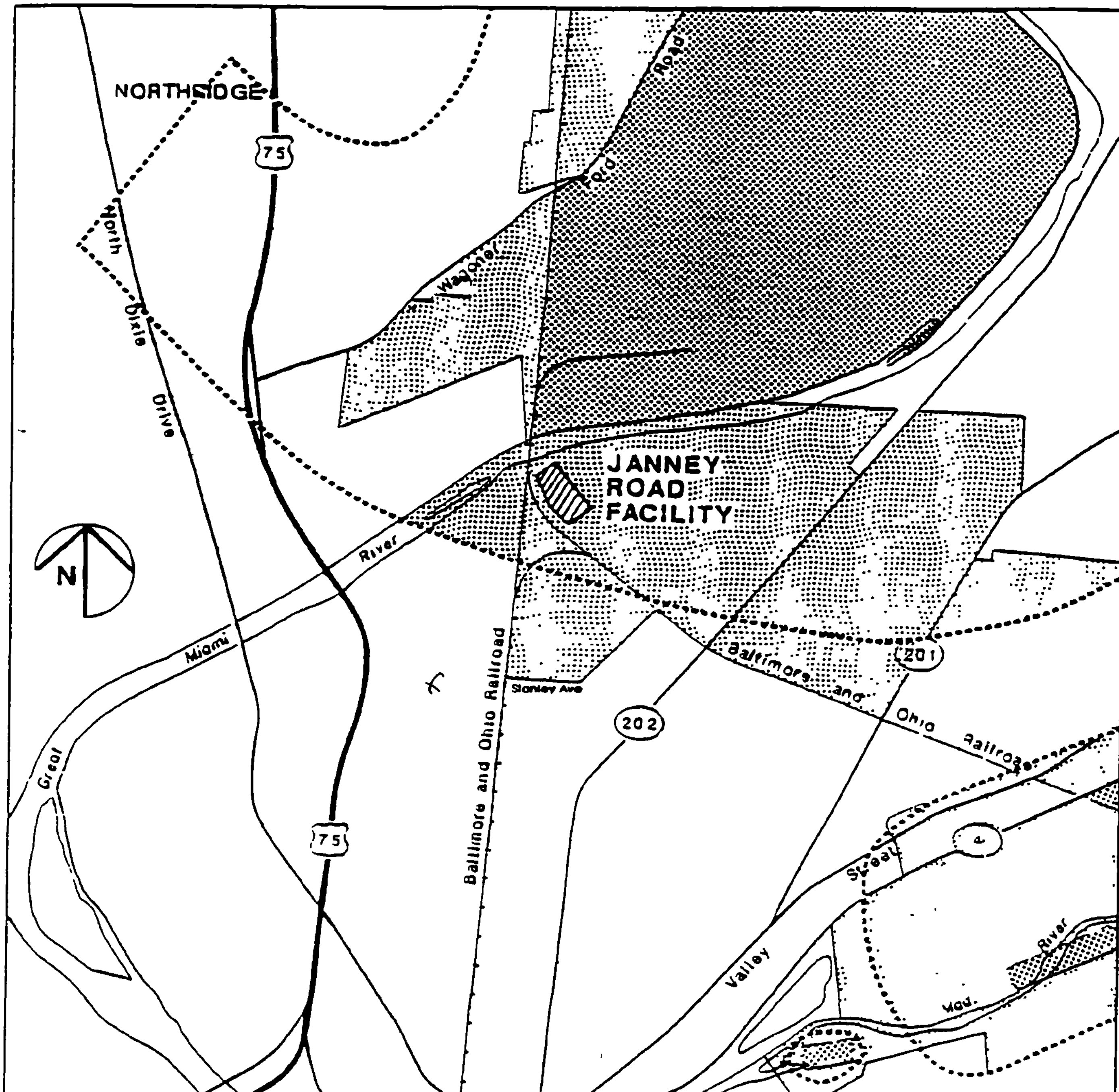
Other water supply wells in the vicinity of the plant site are shown in Figure 12. Available driller logs are contained in Attachment 1. These logs indicate that most of the local wells are located at depths of 30 to 65 feet.

In August of 1988, the City of Dayton adapted a Well Field Protection Program to protect its well field and drinking water supplies. The southern limit of the Miami Well Field Protection Overly District is Stanley Avenue. Well yields for wells within the area as published in Norris & Spiker (1966) range from 20 gallons per minute (No. 209) to a maximum of 1,000 gallons per minute (No 212) A test well in the Miami South Well Field pumped at a rate of 2,283 gallons per minute The City's Mad River Well Field is approximately two miles to the east of the site and does not receive any recharge from this area as reported by Q-Source for Gem City Figure 13 indicates the extent of the wellfield protection district

FIGURE 12



GOLF COURSES
D-80
D-81
D-82
D-84
D-90
H-86
H-87
D-89
H-88
D-83
D-87
D-88
D-99
D-98
H-89
H-90
D-91
D-94
D-97
D-96
D-95
H-97
D-93
M-143
H-91
H-92
D-92
D-18
M-144
H-94
H-96
M-147,8,9
H-93
H-95
M-145
M-146
D-23
D-27
GEM CITY CHEMICALS
D-31
D-24
D-25
D-26
D-29
D-28
D-30
D-32
D-33
D-34
MIAMI
1" = 2000'
Gem City Chemicals
Water Well Locations
ODNR
QSOURCE




| | |
|---|---|
| (dotted shading) | WO Wellhead Operation District |
| (open box) | WP Wellfield Protection Overlay District |
| ---------- | One Year Capture Boundary |

0 2000
Scale in Feet

Reference:
City of Dayton Ordinances 27788, 27789 & 27790

Applied Geotechnology Inc
Geotechnical Engineering
Geology & Hydrogeology

# GROUNDWATER PROTECTION DISTRICTS

DAP Inc.
Janney Road Facility

FIGURE 13

14 937 011 KER 16 September 88

## SECTION 5.0 - REMEDIATION OBJECTIVES

### 5.1 Ohio EPA Policy

The Ohio Environmental Protection Agency Division of Emergency and Remedial Response (DERR) has developed guidance for hazardous waste site investigations and remediation programs. Ohio EPA evaluates every site independently and will not provide generic clean-up guidance or criteria. The policy was originally developed for unregulated hazardous waste sites but is used at Ohio EPA in the Remedial Response Program.

The process begins with determination of site contamination. A site is considered to be hazardous if a contaminant is detected as defined under Ohio Revised Code (ORC) 3734.02 and the contaminants are present on-site at concentrations significantly above background or the contaminants are present on-site and are not detected in representative background samples.

Once it has been determined that contamination exists, it must be determined if contamination poses a threat to public health or the environment Ohio EPA has not developed specific action levels for chemical contaminants Instead, a human health risk assessment must be performed to evaluate health effects caused by site specific contamination

After site contamination has been characterized and risks posed by the contamination established, remedial alternatives can then be developed and evaluated The criteria that Ohio EPA follows is that the alternatives must consider the following

1 Overall protection of human health and the environment;
2 Compliance with applicable or relevant and appropriate standards and/or criteria,
3 Long term effectiveness and permanence,
4 Reduction of toxicity, mobility, or volume through treatment,
5 Short term effectiveness,

6 Implementability;

7 Cost;

8. Community acceptance.

Alternatives should establish remediation goals that meet the criteria outlined. Based on these preliminary findings, the risk assessment should focus on groundwater quality issues since the site is near the North Miami drinking water aquifer. The selected remedy must comply with all known Federal and State applicable or relevant and appropriate standards and/or criteria (ARARs). The following section discusses ARARs and their significance.

## 5.2 ARARs

In the evaluation of potentially applicable technologies to remediate DTPP, various technologies must be evaluated based on implementability and cost effectiveness Before treatment technologies can be selected, however, the applicable or relevant and appropriate requirements (ARARs) must be reviewed. The ARARs that must be reviewed include the following.

- Any applicable or relevant and appropriate standards, requirement, criteria, or limitation under Federal law
- Any promulgated applicable or relevant and appropriate standard, requirement or limitation under State law that is more stringent than the Federal requirement

"Applicable" requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under Federal/State environmental or facility siting law that specifically address a hazardous substance, pollutant, contaminant, remedial action, or location Only those State standards that are identified by a State in a timely manner and that are more stringent than Federal requirements may be applicable

"Relevant and appropriate" requirements are those cleanup standards, standards of control, or other substantive environmental protection requirements, criteria, or limitations promulgated under Federal or State law that, while not "applicable" to a hazardous substance, pollutant, contaminant, remedial action, or location, do address problems or situations sufficiently similar to those encountered that their use is well-suited to the particular site. Only those State standards that are identified by a State in a timely manner and that are more stringent than Federal requirements may be relevant and appropriate.

Additional information that does not meet the definition of potential ARARs may also be considered in determining the necessary level of cleanup for protection of human health or the environment. This "other information to be considered" (TBCs) includes criteria, advisories, or guidance developed by EPA, other Federal agencies, or States to assist in the determination of, for example, health-based levels for a particular contaminant for which there are no ARARs, or the appropriate method for conducting an action Included in this category are health effects, information with a high degree of credibility, and technical information on how to perform or evaluate site investigations or remedial actions, and policy

ARARs are grouped into three broad categories. These categories are as follows.

- Chemical Specific - These are health or risk based numbers that guide site cleanup and they may be based on actual concentration levels
- Location Specific - This would include requirements for site sensitive features such as wetlands, well head protection areas, flood plains, etc
- Action Specific - These ARARs pertain to monitoring requirements, manifesting requirements, etc

Once the contaminants and the concentrations are known at the site, the following Federal and State contaminant specific ARARs should be reviewed

EPA Primary and Secondary Drinking Water Regulations - These regulations were developed as part of Section 1412 of the Safe Drinking Water Regulations. It establishes enforceable maximum contaminant levels (MCLs) and non-enforceable maximum contaminant levels goals (MCLGs). EPA has also promulgated National Secondary Drinking Water Regulations which establish secondary MCLs which primarily affect the odor or appearance of drinking water.

EPA AWQC - This criteria is not legally enforceable but can be used by the states to protect human health from exposure to contaminants from ingestion of aquatic life. It also protects freshwater and aquatic life.

Other ARARs which need to be reviewed to determine if they are relevant to the remedial technologies chosen include:

- Clean Air Act - Three categories NAAQS, National Emissions Standards for Hazardous Air Pollutants (NESHAPS), and New Source Performance Standards (NSPS) 40 CFR Part 60
- Health Effects Assessment
- State of Ohio Surface Water Quality Standards
- RCRA Subtitle C - This may be applicable to materials generated as a by-product of treatment.
- Location Specific ARARs - Should be reviewed including criteria on the Miami Well Field area
- State of Ohio Drinking Water Standards
- State of Ohio Air Pollution Regulations

Other ARARs which were identified but which are not relevant to this site included:

- DOT Rules for Hazardous Materials Transport - Only applies if waste is shipped off-site for analysis, treatment or ultimate disposal.
- RCRA "Land Ban" Disposal Restriction (40 CFR Part 268) - Restricts certain hazardous wastes from being placed or disposed on land unless certain treatment standards are met. Excavation and disposal of certain hazardous wastes will be subjected to LDRs.
- Standards for Owners or Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities (40 CFR Part 264) - These standards only apply to TSDFs if certain types of remedial actions are completed on-site and it applies to off-site facilities that receive hazardous waste for treatment and/or disposal.
- Endangered Species Act of 1978 (16 USC 1531 - 40 CFR Part 502) - This act ensures that an endangered or threatened species is not affected adversely in its habitat. No federally listed endangered or threatened species are located on this site.
- CWA 1977 Section 404 - This section prohibits the discharge of fill material into jurisdictional wetlands without obtaining a permit from the U.S. Army Corps of Engineers. No discharge into wetlands is permitted if an alternative exists for the proposed project Regulations, guidelines, and permit requirements have been established to prevent unregulated dredging, dumping, filling, and similar activities that would destroy these sensitive habitats

# SECTION 6.0 – RECOMMENDATIONS

## 6.1 Overall Recommendations

After a thorough review of on-site and off-site data, it was determined that the following activities/tasks should be completed to fully characterize the site.

- Evaluate subsurface conditions and the vertical stratigraphy of the site. Include both the upper and lower aquifers. A sufficient number of borings should be completed to adequately determine if the first aquifer is a confining or semi-confining layer.
- Establish groundwater flow in the water table and lower aquifer Local data obtained from Gem City Chemicals indicates that groundwater flow has been significantly affected by the pumping of the Greater Miami Wellfield. This should be confirmed
- Several shallow (less than 50 feet) and deep (approximately 100 feet) boreholes should be completed to fully evaluate stratigraphy using split-spoon sampling. Selected boreholes should be completed as monitoring wells.
- Evaluate the groundwater quality of the two aquifers including priority pollutants Conduct pump tests on selected wells to determine if any of the installed wells can later be converted to a groundwater recovery well system
- Halogenated organic compounds were found during the site investigation of the Maxwell Complex and are characterized as DNAPLs or Dense Non-Aqueous Phase Liquids. The heavier-than-water compounds can sink in an aquifer system and migrate downslope as a separate, non-aqueous phase displacing water at they migrate Residual DNAPL can remain within the vadose and saturated zones, trapped by surface tension within soil pore spaces The compounds will typically continue to migrate vertically until they become deposited in pore spaces or until they reach a less permeable layer, such as a till or clay If the impermeable layer is sufficiently sloped, DNAPLs may "pool" in depressions

DNAPLs can migrate in directions other than the direction of groundwater flow DNAPLs in the vadose zone dissolve into the water and vaporize into soil gas. Therefore, since the site may contain compounds which includes DNAPLs, the following should be evaluated at the site:

1. Determine DNAPL concentrations of compounds which may be as low as 1% saturation of a certain DNAPLs solubility.
2. Determine the presence of dissolved phase chemicals upgradient.
3. Confirm through analysis soil gas data which indicates "hot spots".

- Develop remedial alternatives which should include an evaluation of combinations of treatment technologies such as: soil vacuum extraction, groundwater pumping and treatment, stream injection, bioremediation, and soil flushing.
- The nearby Gem City Chemicals, Inc site has a recovery well system and an air stripper to recover DNAPLs. Studies at this site concluded that there was no separate phase caused by DNAPLs beneath Gem City Chemicals, Inc The concentrations measured at the site and the solubility of the chlorinated compounds were compared. It appears that the concentrations found at Gem City are below maximum solubilities of these compounds which would indicate that the compounds are dissolved and are moving with the groundwater and not migrating as a separate phase. In addition, the concentrations of solvents found in the monitoring wells were highest at the shallow depths and are near non-detect at the bottom of the aquifer It appears that the DNAPLs are traveling with the direction of groundwater flow which would be away from DTPP In order to confirm this, wells should be installed near the property boundary between Gem City and DTPP

The following section outlines the preparation of a plan to implement installation of monitoring wells and soil borings to characterize the site

### 6.2 Field Sampling Plan (FSP) Outline

The primary purpose of the soil boring program is to characterize the site's geology and to obtain samples for geotechnical analysis. The FSP also provides the sampling rationale, procedures, and deliverables to be used in the implementation of field sampling activities. The FSP will include the following items:

a) One or more maps depicting proposed sampling locations. A site survey map should also be completed which will be prepared at 1 inch equals 20 feet. Vertical control will be referenced to the National Geologic Vertical Datum (NGVD) Horizontal control will be referenced to the Ohio State Plane Coordinate System.
b) A detailed description of all sampling, analysis, testing and monitoring to be performed including sampling methods, analytical and testing methods, and frequency of sampling and sampling locations
c) An analysis of Data Quality Objectives (DQOs) describing how the sampling, analysis, testing and monitoring will produce data useful for meeting the objectives of remediating the site.
d) A schedule for performance of specific sampling and testing tasks
e) A description of geophysical investigations to better define subsurface conditions applicable to characterize the subsurface.

Other items to be addressed include

- Inspection of the work,
- Daily documentation logging,
- As-built drawings,
- Health & Safety Plan, site specific,
- Coordination of activities

All drilling activities will be completed using a 4¼" ID hollow stem auger with split-spoon sampling continuously at 2 foot intervals until the lower confining unit is reached. A geologic cross section will be prepared. All soil cuttings will be field screened for organic vapors.

Large diameter (3 inch) spilt-spoons will be used for the collection of samples for geotechnical laboratory tests. Blow counts will be recorded and standard penetration noted. Grain size analysis should be performed as required using ASTM 422. Moisture content using ASTM Method 2216 and Atterberg limit tests should be performed in conjunction with the grain-size analysis.

Quality Assurance Plan

Where appropriate, analysis will be performed in accordance with EPA methods and procedures The following items should be included in each analytical report

- Title Page,
- Table of Contents,
- QA Objectives,
- Sampling Procedures,
- Sample Custody;
- Calibration Procedures and Frequency;
- Analytical Procedures;
- Data Reduction, Validating and Reporting;
- Quality Assurance Reports.

After the borings have been logged and completed, several will be converted to monitoring wells with five foot stainless steel screens. Screen locations will be selected by the driller based on results of the boring program and groundwater sampling

# Attachment 1
# Well Logs

91-L ORIGIN

# WELL LOG AND DRILLING REPORT

State of Ohio
OHIO WATER RESOURCES BOARD
Department of Public Works
553 E. Broad St., Columbus 15, Ohio

No. 62814

County Montgomery Township Harrison Section of Township or Lot Number 2619 Koehler

Owner Silas Jones Address 2619 Koehler ave

Location of property North Ridge Dayton

| CONSTRUCTION DETAILS | PUMPING TEST |
|---|---|
| Casing diameter 4 1/4 Length of casing 36 | Pumping rate ____ G.P.M. Duration of test ____ hr |
| Type of screen ____ Length of screen ____ | Drawdown ____ ft. Date ____ |
| Type of pump No Pump | Developed capacity ____ |
| Capacity of pump ____ | Static level of completed well ____ ft. |
| Depth of pump setting ____ | Pump installed by ____ |

## WELL LOG

| Formations Sandstone, shale, limestone, gravel and clay | From | To |
|---|---|---|
| Top soil | 0 Feet | 3 Ft. |
| Gravel & sand | 3 | 34 |
| water gravel | 34 | 36 |
| 10 ft water | | |
| Dip test at approx | | |
| ? G.P.M. | | |

Do not need

## SKETCH SHOWING LOCATION

Locate in reference to numbered State Highways, St. Intersections, County roads, etc.

N.

2619
Koehler ave
North Ridge
Dayton Ohio

W. E.

.05 mi. West 2??
Needs

S.

See reverse side for instructions

Drilling Firm EARL HOLLANDSWORTH Well Drilling

Address 2535 Ome Avenue - North Ridge DAYTON, OHIO

Date Sept 3 - 49

Signed Earl Hollandsworth

-1,529,700
(500X500)
-651,000-S

# WELL LOG AND DRILLING REPORT

State of Ohio
OHIO WATER RESOURCES BOARD
Department of Public Works
553 E. Broad St., Columbus 15, Ohio

No. 48551

County Montgomery Township Harrison Twp Section of Township or Lot Number

Owner Leonard Plubs Address 4612 Ross

Location of property ½ mile from State Rout 25

## CONSTRUCTION DETAILS

well rut 7'

Casing diameter Line Length of casing 36½

Type of screen Length of screen

Type of pump JET

Capacity of pump 300 gal per hr

Depth of pump setting 30 ft (37' from top of Ground)

## PUMPING TEST

Pumping rate 10 G.P.M. Duration of test 1 hr

Drawdown none ft. Date Nov 4 1942

Developed capacity Not Known

Static level of completed well 25 ft.

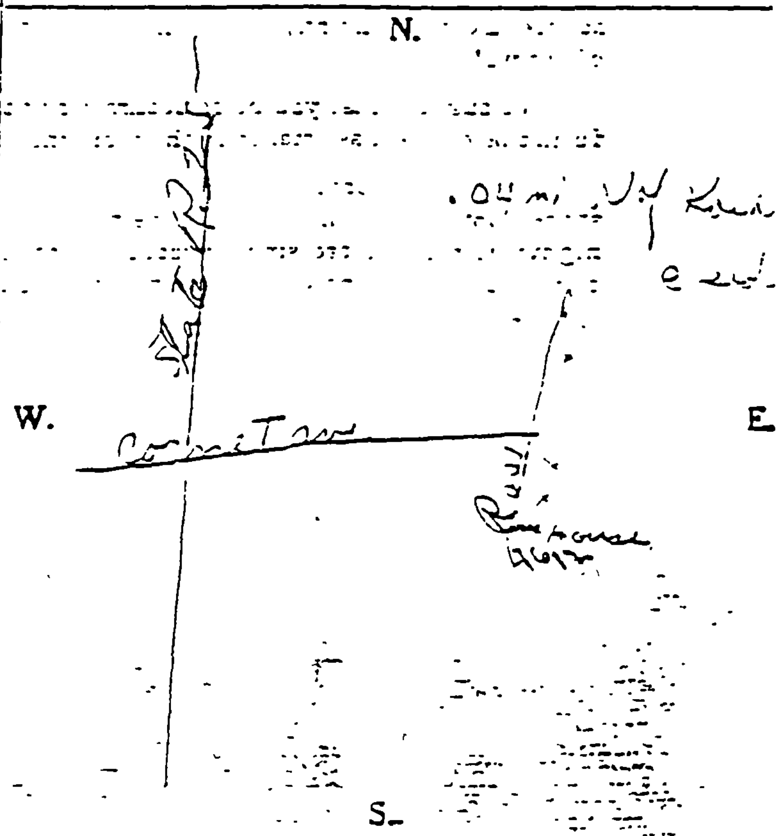
Pump installed by owner

## WELL LOG

| Formations Sandstone, shale, limestone, gravel and clay | From | To |
|---|---|---|
| | 0 Feet | 2½ Ft. |
| Soil | | |
| Sand | 2½ | 41 |
| gravel | 41 | 43½ |

## SKETCH SHOWING LOCATION

Locate in reference to numbered State Highways, St. Intersections, County roads, etc.




See reverse side for instructions

Drilling Firm R W [illegible] + Earl H Fry Date: Nov 4 1942

Address 2244 [illegible] Signed Earl H Fry
2244 [illegible]

# WELL LOG AND DRILLING REPORT

ORIG
34

State of Ohio
DEPARTMENT OF NATURAL RESOURCES
Division of Water
Columbus, Ohio

No 109299

I - 1,528,200
(4000 Y00)
J - 659,303-S

County Montgomery Township Harrison Section of Township or Lot Number north East

Owner Herman Meerhoff Address 2817 Koehlar Ave

Location of property ½ mi north traffic circle ½ mi East US # 25 North Ridge

| CONSTRUCTION DETAILS | |
|---|---|
| Casing diameter 6¼" | Length of casing 32' |
| Type of screen none | Length of screen |
| Type of pump none | |
| Capacity of pump | |
| Depth of pump setting | |

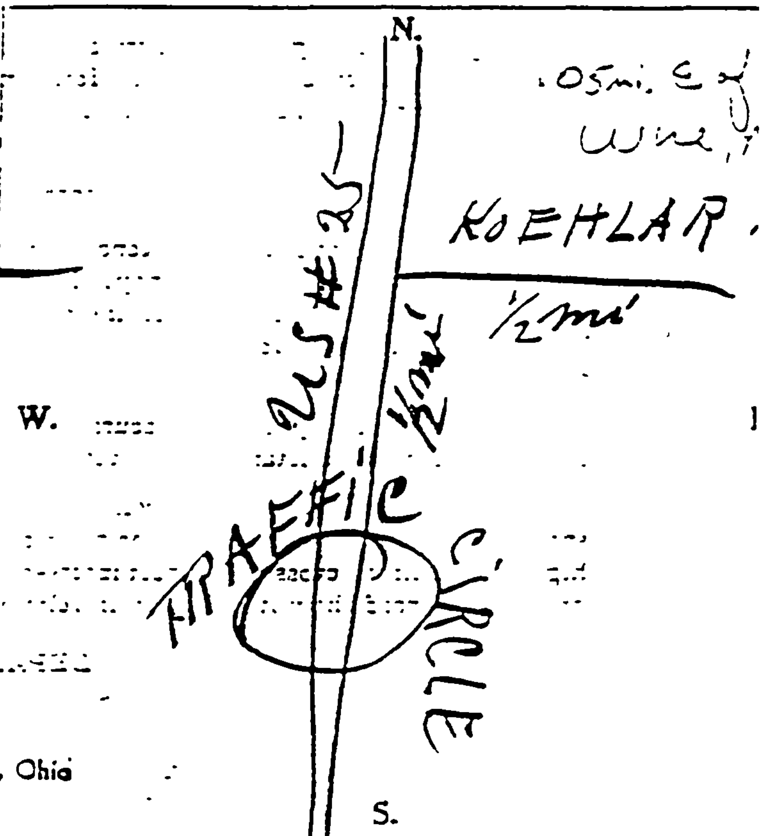
| PUMPING TEST | |
|---|---|
| Pumping rate 36 G.P.M. | Duration of test 2 |
| Drawdown none ft. | Date 9-17-53 |
| Developed capacity 2160 gal Per hr | |
| Static level—depth to water 21 | |
| Pump installed by owner | |

## WELL LOG

| Formations Sandstone, shale, limestone, gravel and clay | From | To |
|---|---|---|
| gravel | 0 Feet | 32 Ft. |
| 11 ft standing water no drawdown | | |

## SKETCH SHOWING LOCATION

Locate in reference to numbered State Highways, St. Intersections, County roads, etc.




DAVID L. SULLIVAN
WATER WELL DRILLING
PUMPS INSTALLED
4917 Woodland Hills Blvd. Dayton, Ohio
All Work Guaranteed TA 3684

See reverse side for instructions

Drilling Firm David Sullivan Date Sept 17-1953

Address 4917 woodland hills Blvd Signed David L. Sullivan

1,526,000
(500 x 500)
664,800 – 5

# WELL LOG AND DRILLING REPORT

OHIO WATER RESOURCES BOARD
Department of Public Works
553 E. Broad St., Columbus 15, Ohio

No. 49181

28

County Montgomery Township Harrison Section of Township or Lot Number

Owner Ray Smart Address 2711 Sheron Av

Location of property 1 mile South of Needmore Rd. and ½ mile East of RT 25

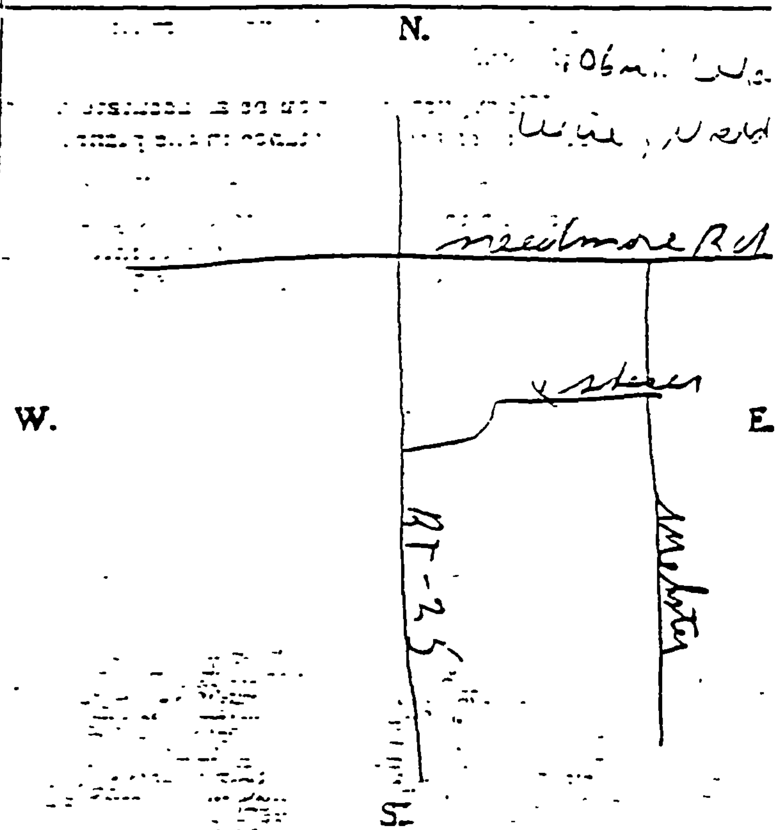
| CONSTRUCTION DETAILS | | PUMPING TEST | |
|---|---|---|---|
| Casing diameter 6" | Length of casing 89 | Pumping rate G.P.M. | Duration of test |
| Type of screen | Length of screen | Drawdown 5 ft. | Date |
| Type of pump Jet | | Developed capacity 1000 gal per Hr. | |
| Capacity of pump | | Static level of completed well 34 ft. | |
| Depth of pump setting | | Pump installed by R. B. Billman Co. | |

## WELL LOG

| Formations Sandstone, shale, limestone, gravel and clay | From | To |
|---|---|---|
| fill | 0 Feet | 6 Ft. |
| clay - Gravel | 6 | 47 |
| Hardpan | 47 | 55 |
| Clay & Gravel | 55 | 60 |
| fine sand | 60 | 75 |
| Hardpan | 75 | 77 |
| muddy sand | 77 | 83 |
| Hardpan | 83 | 85 |
| water bearing sand & Gravel | 85 | 89 |

## SKETCH SHOWING LOCATION

Locate in reference to numbered State Highways, St. Intersections, County roads, etc.




See reverse side for instructions

Drilling Firm W. U. Scott
Address R.R. 3 Box 214-B Dayton, O.

Date 9-6-54
Signed W. U. Scott

ORIGIN

# WELL LOG AND DRILLING REPORT

~~State of Ohio~~
~~DEPARTMENT OF NATURAL RESOURCES~~
Division of Water
Columbus, Ohio

Nº 129071

County Montgomery Township Harrison Section of Township or Lot Number

Owner Wilbert Minnich Address 1104 Ross Ave.

Location of property North on Super High Way East on Kennan Ave 2 Blocks on Ross

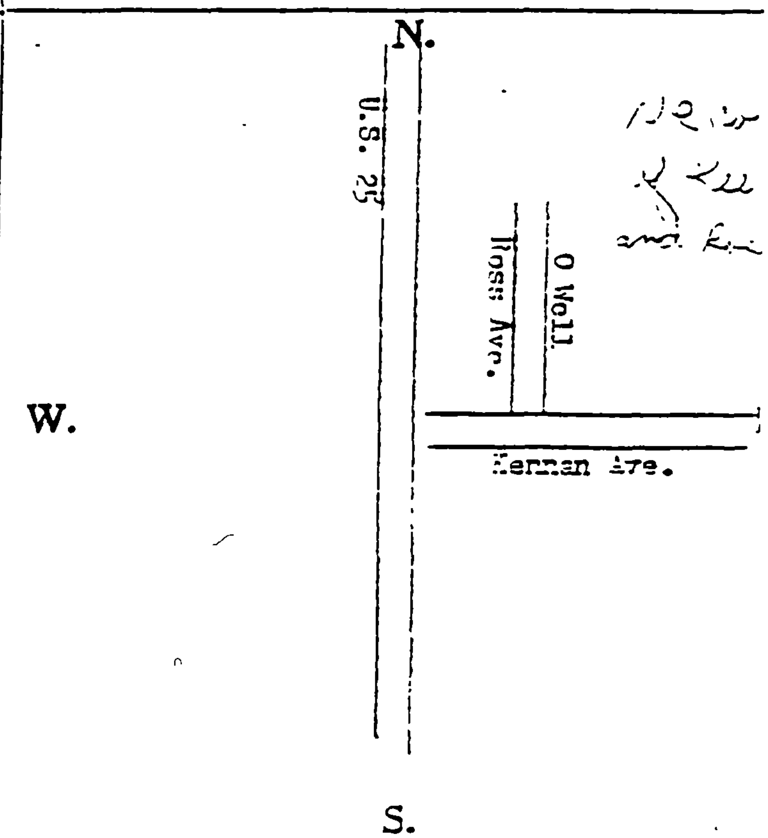
| CONSTRUCTION DETAILS | PUMPING TEST |
|---|---|
| Casing diameter 1¼" Length of casing 47 Ft. | Pumping rate G.P.M. Duration of test |
| Type of screen Length of screen | Drawdown ft. Date April 29 1954 |
| Type of pump | Developed capacity |
| Capacity of pump | Static level—depth to water 28 |
| Depth of pump setting | Pump installed by |

## WELL LOG

| Formations Sandstone, shale, limestone, gravel and clay | From | To |
|---|---|---|
| Dry Gravel | 0 Feet | 30 Ft. |
| Gravel & Water | 30 " | 47 " |

## SKETCH SHOWING LOCATION

Locate in reference to numbered State Highways, St. Intersections, County roads, etc.




See reverse side for instructions

Drilling Firm EARL HOLLANDSWORTH Well Drilling

Address Ohio Avenue - North Ridge DAYTON, OHIO

Date April 29 1954

Signed Nellie Hollandsworth

# WEL LOG AND DRILLING REPORT

ORIGI

State of Ohio
DEPARTMENT OF NATURAL RESOURCES
Division of Water
1562 W. First Avenue
Columbus 12, Ohio

PLEASE USE PENCIL
OR TYPEWRITER
DO NOT USE INK.

№ 300566

County Montgomery Township Madison Section of Township

Owner Howard Wick Address 2615 Neff Rd. Dayton O

Location of property 2615 Neff Rd Dayton Ohio

| CONSTRUCTION DETAILS | BAILING OR PUMPING TEST |
|---|---|
| Casing diameter 5 1/2 Length of casing 63' | Pumping Rate 20 G.P.M. Duration of test 1 1/2 hr |
| Type of screen None Length of screen — | Drawdown 5' ft. Date Jan - 16 - 64 |
| Type of pump Jet or Deep Well | Static level-depth to water 20 f |
| Capacity of pump 6 GPM | Quality (clear, cloudy, taste, odor) Clear |
| Depth of pump setting 50' | |
| Date of completion Jan 16 - 64 | Pump installed by Chas E. Hamilton |

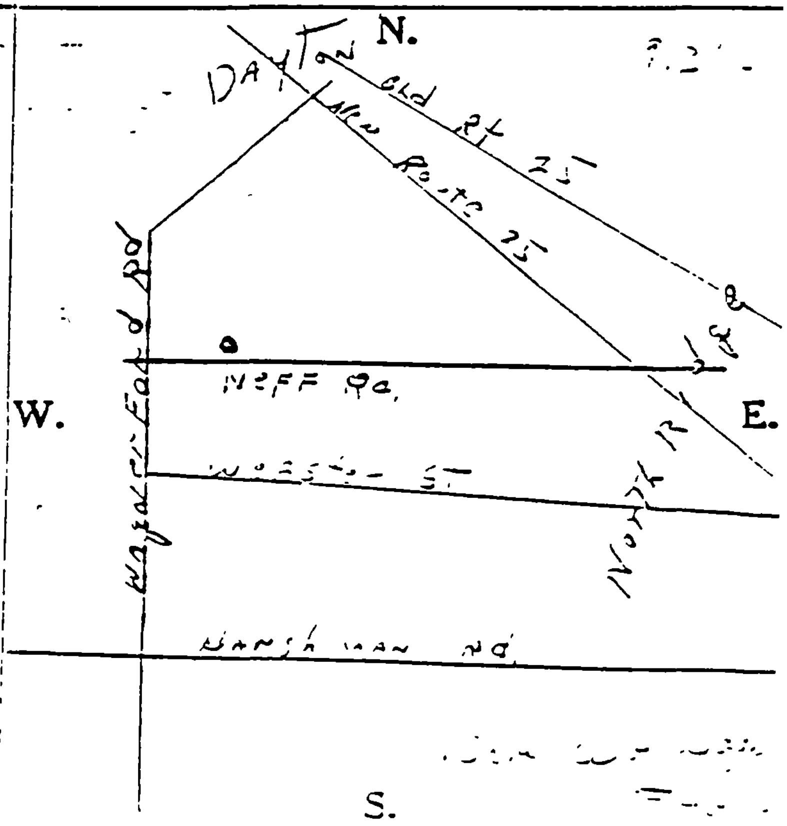
## WELL LOG

| Formations Sandstone, shale, limestone, gravel and clay | From | To |
|---|---|---|
| Clay | 0 Feet | 4 Ft. |
| Gravel | 4 | 55 |
| Blue Clay | 55 | 60 |
| Sand + gravel | 60 | 63 |

Water at 60 - 63 FT.

## SKETCH SHOWING LOCATION

Locate in reference to numbered State Highways, St. Intersections, County roads, etc.




See reverse side for instructions

Drilling Firm Chas E Hamilton Date Jan - 16 - 64

Address 613 Waneta Ave Signed Charles E Hamilton

# WELL LOG AND DRILLING REPORT

State of Ohio
DEPARTMENT OF NATURAL RESOURCES
Division of Water
1562 W. First Avenue
Columbus, Ohio 43212

PLEASE USE PENCIL OR TYPEWRITER

DO NOT USE INK

52

Nº 36803

County Montgomery Township ~~Butler~~ Harrison Section of Township

Owner Carl Hill Address 2627 Neff Rd.

Location of property

| CONSTRUCTION DETAILS | |
|---|---|
| Casing diameter 5¼ | Length of casing 66 |
| Type of screen | Length of screen |
| Type of pump | |
| Capacity of pump | |
| Depth of pump setting | |
| Date of completion | |

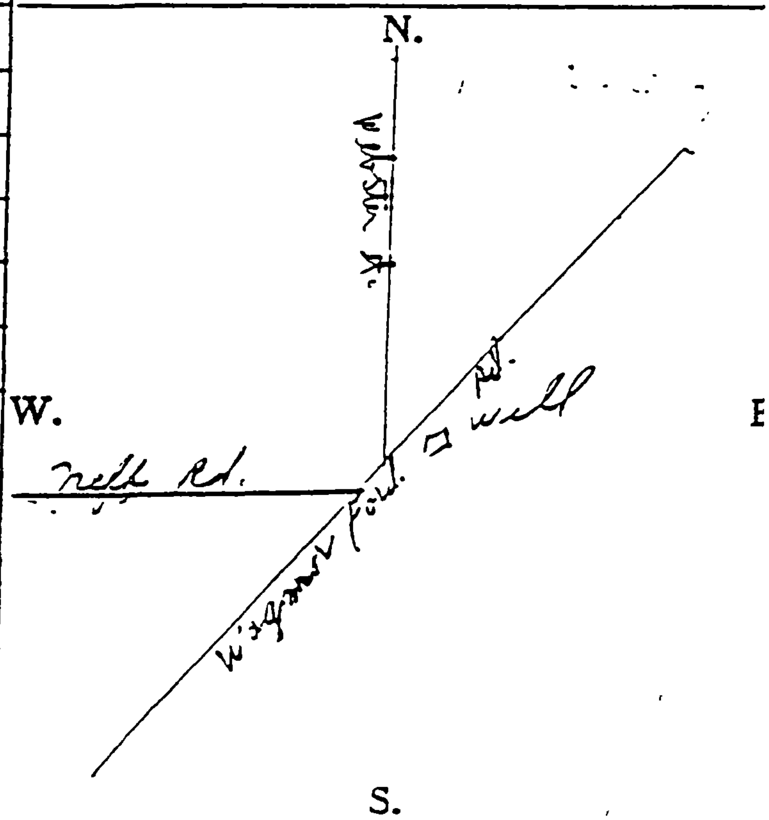
| BAILING OR PUMPING TEST | |
|---|---|
| Pumping Rate 10 G.P.M. | Duration of test |
| Drawdown 45 ft. | Date Dec 67 |
| Static level-depth to water 35 | |
| Quality (clear, cloudy, taste, odor) | |
| Pump installed by | |

## WELL LOG*

| Formations Sandstone, shale, limestone, gravel and clay | From | To |
|---|---|---|
| Overburden | 0 Feet | 4 Ft. |
| Sand and Gravel Clay | 4 | 44 |
| Clay Gravel | 44 | 64 |
| Clay | 64 | 65 |
| Gravel Water | 65 | 66 |

## SKETCH SHOWING LOCATION

Locate in reference to numbered State Highways, St. Intersections, County roads, etc




See reverse side for instructions

Drilling Firm Brenner Well Drilling Date Dec 18 67

Address 5565 Dayton Brandt Rd. Tipp City Ohio Signed Donald K Brenner

*If additional space is needed to complete well log

# WEL' LOG AND DRILLING REPORT

NO CARBON PAPER NECESSARY— SELF-TRANSCRIBING

State of Ohio
DEPARTMENT OF NATURAL RESOURCES
Division of Water
65 S. Front St., Rm. 815 Phone (614) 469-2646
Columbus, Ohio 43215

No. 420727

County Montgomery Township German Section of Township 12

Owner Village of Germantown Address Germantown, Ohio 453[illegible]

Location of property

## CONSTRUCTION DETAILS

Casing diameter 10" Length of casing 42'
Type of screen R.B. Length of screen 7'
Type of pump None
Capacity of pump
Depth of pump setting
Date of completion

## BAILING OR PUMPING TEST
(Specify one by circling)

Test Rate 317 G.P.M. Duration of test 7 1/2
Drawdown 24' 3" ft. Date March 29, 1972
Static level-depth to water 11'
Quality (clear, cloudy, taste, odor) Clear

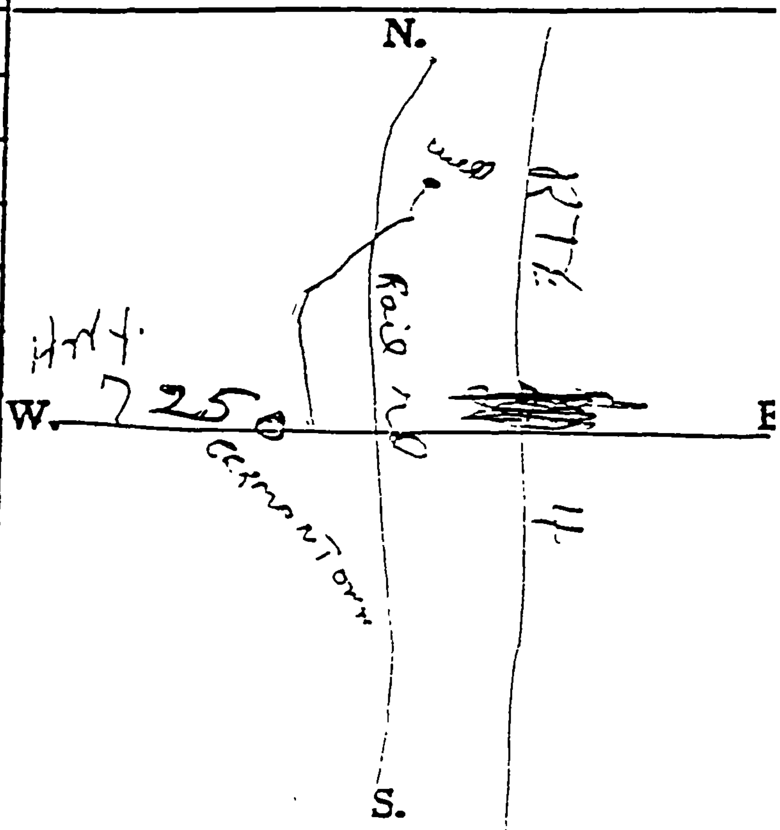
Pump installed by

## WELL LOG*

| Formations Sandstone, shale, limestone, gravel and clay | From | To |
|---|---|---|
| Top Soil | 0 Feet | 3 Ft. |
| Dry Gravel | 3' | 8' |
| Coarse Gravel (dry) | 8' | 13' |
| Clay | 13' | 16' |
| Coarse gravel-Boulders | 16' | 25' |
| Dirty Gravel | 25' | 29' |
| Coarse Sand-med. Gravel | 29' | 34' |
| Sandy Clay | 34' | 40' |
| Soft Shale | 40' | 42' |

## SKETCH SHOWING LOCATION

Locate in reference to numbered State Highways, St. Intersections, County roads, etc




Drilling Firm MOODY'S OF DAYTON, INC. Date Dec 8, 1975

Address P.O. Box 123, 4359 Infirmary Road, Miamisburg, Ohio 45342, 513-859-4482

Signed C.O. Burgess

X = 1,526,800
(500 x 500)
Y = 661,700-5

# WELL LOG AND DRILLING REPORT

State of Ohio
DEPARTMENT OF NATURAL RESOURCES
Division of Water
Columbus, Ohio

№ 111070

County Montg. Township Harrison Section of Township or Lot Number ——

Owner Richard Brandon Address 2266 Gifford rd. Dayton

Location of property Intersection Super Highway and Gifford rd.

| CONSTRUCTION DETAILS | | PUMPING TEST | |
|---|---|---|---|
| Casing diameter 5" | Length of casing 53' | Pumping rate 12½ G.P.M. | Duration of test 1 |
| Type of screen —— | Length of screen —— | Drawdown 3 ft. | Date 2-28-54 |
| Type of pump —— | | Developed capacity 250 gal. [illegible] | |
| Capacity of pump —— | | Static level—depth to water 28 | |
| Depth of pump setting —— | | Pump installed by —— | |

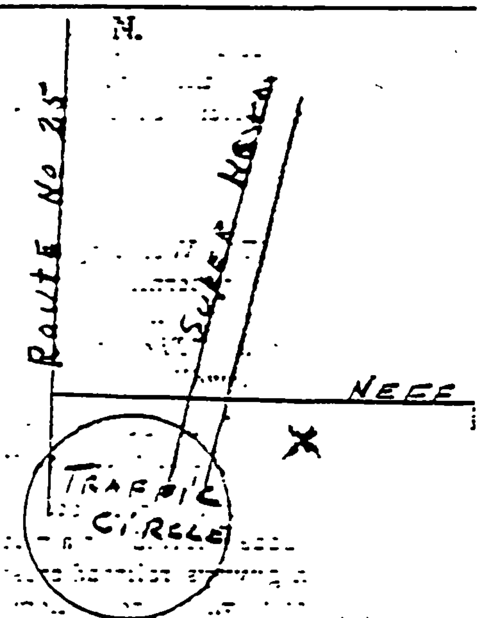
## WELL LOG

| Formations Sandstone, shale, limestone, gravel and clay | From | To |
|---|---|---|
| Clay | 0 Feet | 6 Ft. |
| Gravel & clay | 6 | 32 |
| gravel | 32 | 37 |
| Clay | 37 | 51 |
| gravel | 51 | 53 |

water 51-53'

## SKETCH SHOWING LOCATION

Locate in reference to numbered State Highways, St. Intersections, County roads, etc.




SW corner of Neff Rd and Hwy

See reverse side for instructions

Drilling Firm M. J. Spencer Date Feb. 28 1954

Address 340 Guernsey ave. Signed Marvin J. Spencer

(-1,525,900
(500 x 500)
-659,900 -S

# WELL LOG AND DRILLING REPORT

State of Ohio
DEPARTMENT OF NATURAL RESOURCES
Division of Water
Columbus, Ohio

Nº 136521

County Montgomery Township Harrison Section of Township or Lot Number 5
Owner Northridge School Board Address
Location of property Grafton Kennedy School Wagner Ford R

| CONSTRUCTION DETAILS | PUMPING TEST |
|---|---|
| Casing diameter 6" OD Length of casing 115 | Pumping rate 40 G.P.M. Duration of test 8 |
| Type of screen Cook #60 Length of screen 8' | Drawdown 0 ft. Date 9-1-54 |
| Type of pump Myers Submergible | Developed capacity 40 G.P.M. |
| Capacity of pump 1500 G.P.H. | Static level—depth to water 30' |
| Depth of pump setting 80' | Pump installed by W. S. Williams |

## WELL LOG

| Formations Sandstone, shale, limestone, gravel and clay | From. | To |
|---|---|---|
| | 0 Feet | Ft. |
| Sandy clay | 0 | 21 |
| Gravel and clay | 21 | 70 |
| Sand | 70 | 105 |
| Gravel | 105 | 115 |

## SKETCH SHOWING LOCATION

Locate in reference to numbered State Highways, St. Intersections, County roads, etc.

N.
W.
Route 25
Well
O
Wagner Ford Rd
S.

See reverse side for instructions

Drilling Firm W. S. Williams Date 9-1-54
Address R#2 Miamisburg Signed W. S. Williams

# WELL LOG AND DRILLING REPORT

ORIG

State of Ohio
DEPARTMENT OF NATURAL RESOURCES
Division of Water
1562 W. First Avenue
Columbus 12, Ohio

PLEASE USE PENCIL
OR TYPEWRITER
DO NOT USE INK

No 278540

County Montgomery Township [illegible] Section of Township 15

Owner Board of [illegible] Cemetery Address 3690 Wagner Ford Rd

Location of property 1/2 mile east of RR 75 on Wagner Ford Rd.

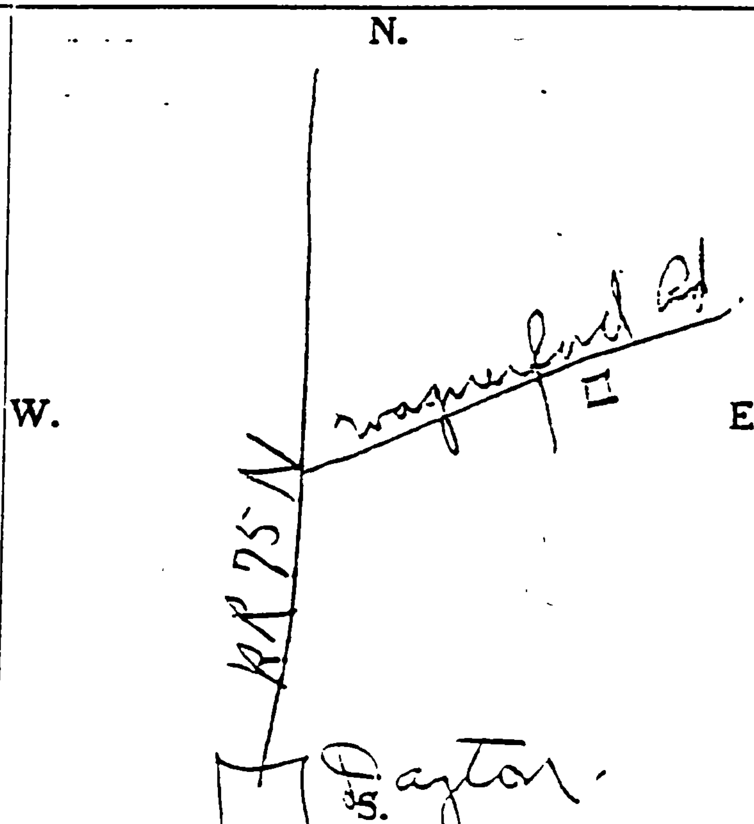
| CONSTRUCTION DETAILS | BAILING OR PUMPING TEST |
|---|---|
| Casing diameter 5" Length of casing 60 | Pumping Rate 10 G.P.M. Duration of test 1 hrs |
| Type of screen Length of screen | Drawdown 5 ft. Date Sept 1 62 |
| Type of pump | Static level-depth to water 96' ft |
| Capacity of pump | Quality (clear, cloudy, taste, odor) Clear |
| Depth of pump setting | |
| Date of completion | Pump installed by |

## WELL LOG

| Formations Sandstone, shale, limestone, gravel and clay | From | To |
|---|---|---|
| Clay | 0 Feet | 20 Ft. |
| sand & gravel | 20 | 42 |
| Clay | 42 | 59 |
| gravel | 59 | 60 |

## SKETCH SHOWING LOCATION

Locate in reference to numbered State Highways, St. Intersections, County roads, etc.




See reverse side for instructions

Drilling Firm CLAY P GARRISON
WELL CONTRACTOR

Address ~~3501 S. DIXIE DR.~~
DAYTON 9, OHIO

Date Sept 3 1962

Signed Clay P Garrison

, =1,537,200
(1000 x 1100)
1. =665,600 - S

# WELL LOG AND DRILLING REPORT

ORIGI

State of Ohio
DEPARTMENT OF NATURAL RESOURCES
Division of Water
Columbus, Ohio

H ✓

№ 129088

County Montgomery Township Harrison Section of Township or Lot Number Northridge

Owner Robert W. Burke Address 3300 Susannah Avenue Dayton 4, Ohio

Location of property Susannah Avenue Northridge, Dayton 4, Ohio

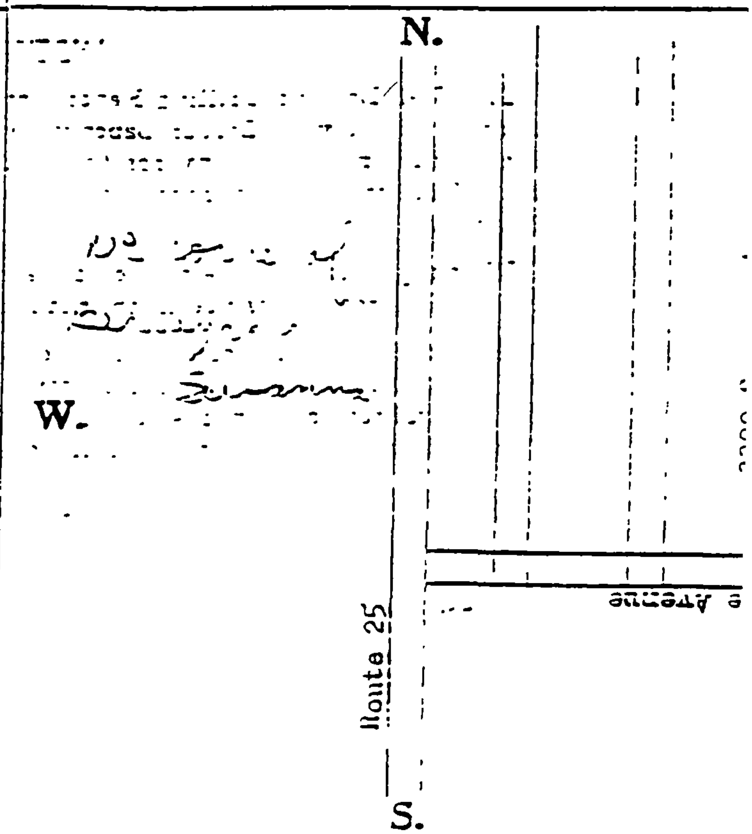
| CONSTRUCTION DETAILS | PUMPING TEST |
|---|---|
| Casing diameter 4" Length of casing 37' | Pumping rate ____ G.P.M. Duration of test ____ |
| Type of screen ____ Length of screen ____ | Drawdown ____ ft. Date ____ |
| Type of pump ____ | Developed capacity ____ |
| Capacity of pump ____ | Static level—depth to water ____ |
| Depth of pump setting ____ | Pump installed by ____ |

## WELL LOG

| Formations Sandstone, shale, limestone, gravel and clay | From | To |
|---|---|---|
| Top soil | 0 Feet | 2 Ft. |
| Sand and Gravel | 2 | 12 |
| Bolders | 12 | 14 |
| Sand | 14 | 33 |
| Clay and Gravel | 33 | 35 |
| Sand and Gravel, Water | 35 | 37 |
| Dip test at approx. 10 G.P.M. | | |

## SKETCH SHOWING LOCATION

Locate in reference to numbered State Highways, St. Intersections, County roads, etc.




See reverse side for instructions

Drilling Firm EARL HOLLANDSWORTH, Inc. Date June 10 1954

Address 2538 ___ Avenue Dayton, Ohio Signed [signature]

V = 1,525,000 (2000 x 2000)
637,800 - S

# WELL LOG AND DRILLING REPORT

State of Ohio
OHIO WATER RESOURCES BOARD
Department of Public Works
553 E. Broad St., Columbus 15, Ohio

ORIGINAL

No. 62840

(15)

County Montgomery Township Harrison Section of Township or Lot Number Emery Park Plat

Owner Clark Melton Address 2509 Neva Avenue Dayton 4, Ohio

Location of property 2509 Neva Avenue 4 blocks East of State Route 25 3 blocks North of the Great Miami River.

## CONSTRUCTION DETAILS

Casing diameter 1" Length of casing 30'

Type of screen ______ Length of screen ______

Type of pump ______

Capacity of pump ______

Depth of pump setting ______

## PUMPING TEST

Pumping rate ______ G.P.M. Duration of test ______

Drawdown ______ ft. Date ______

Developed capacity ______

Static level of completed well 0' ft.

Pump installed by ______

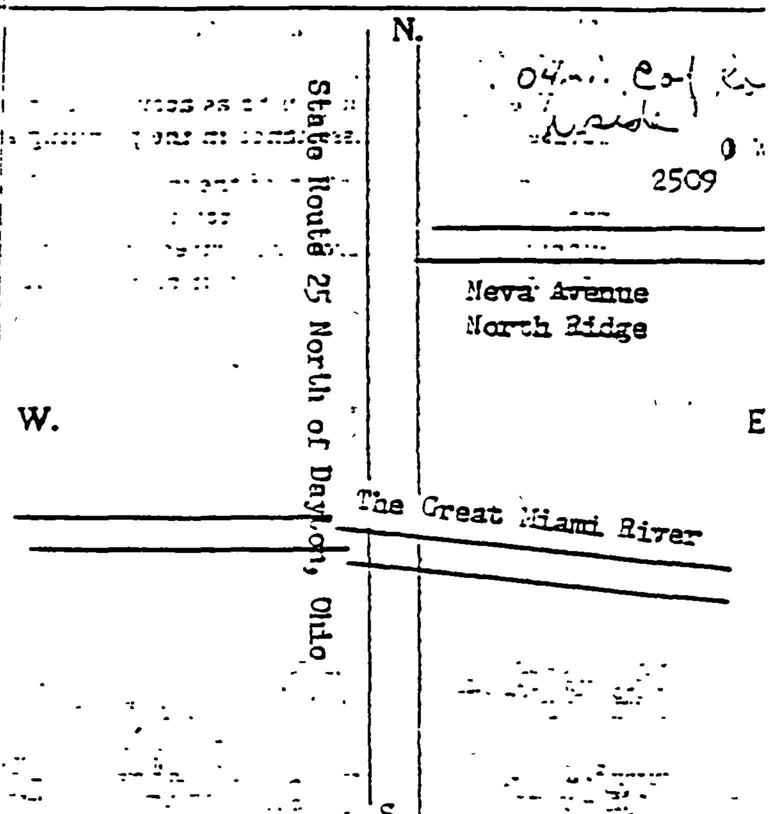
## WELL LOG

| Formations Sandstone, shale, limestone, gravel and clay | From | To |
|---|---|---|
| Top Soil | 0 Feet | 4 Ft. |
| Clay | 4 | 14 |
| Clay & Gravel | 14 | 20 |
| Sand, some Gravel | 20 | 30 |

Dip test at approx.
12 G.P.M.

## SKETCH SHOWING LOCATION

Locate in reference to numbered State Highways, St. Intersections, County roads, etc.




See reverse side for instructions

Drilling Firm EARL HOLLANDSWORTH ~~Well Drilling~~ Date June 16 1953

Address 1533 Ome Avenue - North Ridge DAYTON, OHIO Signed Earl Hollandsworth

1,524,500
(3000 x 3000)

# WELL LOG AND DRILLING REPORT

State of Ohio
OHIO WATER RESOURCES BOARD
Department of Public Works
553 E. Broad St., Columbus 15, Ohio

No. 47425

County MONTgomery Township Harrison Section of Township or Lot Number North Ridge

Owner F. W. Ledermond Address 2424 Oneida a

Location of property 2424 Oneida ave North Ridge

| CONSTRUCTION DETAILS | |
|---|---|
| Casing diameter 5 3/4 | Length of casing 38' |
| Type of screen | Length of screen – |
| Type of pump None | |
| Capacity of pump | |
| Depth of pump setting | |

| PUMPING TEST | |
|---|---|
| Pumping rate G.P.M. | Duration of test |
| Drawdown ft. | Date |
| Developed capacity | |
| Static level of completed well ft. | |
| Pump installed by | |

## WELL LOG

| Formations Sandstone, shale, limestone, gravel and clay | From | To |
|---|---|---|
| Clay + gravel | 0 Feet | 20 Ft. |
| Water gravel | 20 | 25 |
| Blue Clay + gravel | 25 | 32 |
| Sand & gravel | 32 | 38 |
| 22 ft water | | |
| Pump test at | | |
| 4 pr at 20 G.P.M | | |
| No draw down | | |

## SKETCH SHOWING LOCATION

Locate in reference to numbered State Highways, St. Intersections, County roads, etc.

N.
W.
E
S.
10 ft. ave
Well
Oneida ave
US Rt 25

See reverse side for instructions

Drilling Firm EARL HOLLANDSWORTH Well Drilling

Address 2538 Oneida Avenue - North Ridge DAYTON, OHIO

Date 8-21-48

Signed Earl Hollandsworth

# WELL LOG AND DRILLING REPORT

State of Ohio
DEPARTMENT OF NATURAL RESOURCES
Division of Water
Columbus, Ohio

ORIGI

E V

Nº 146319

County Montgomery Township Harrison Section of Township or Lot Number Northridge

Owner Lester E. Brunkers Address 2516 Oneida Avenue Dayton 4, Ohio

Location of property 2516 Oneida Avenue (Northridge) Dayton 4, Ohio

## CONSTRUCTION DETAILS

Casing diameter 1¼" Length of casing 42'

Type of screen Length of screen

Type of pump Hand pump

Capacity of pump

Depth of pump setting

## PUMPING TEST

Pumping rate G.P.M. Duration of test

Drawdown ft. Date

Developed capacity

Static level—depth to water 9'

Pump installed by

## WELL LOG

| Formations Sandstone, shale, limestone, gravel and clay | From | To |
|---|---|---|
| Top soil | 0 Feet | 3 Ft. |
| Clay | 3 | 9 |
| Clay and Gravel | 9 | 15 |
| Sand and Gravel, Silt | 15 | 35 |
| Sand and Gravel | 35 | 42 |
| Dip test at approx. 10 G.P.M. | | |

## SKETCH SHOWING LOCATION

Locate in reference to numbered State Highways, St. Intersections, County roads, et

N.

.07 mi. e of ...

S side

W.

S.

See reverse side for instructions

RECEIVED

1955 FEB 24

Drilling Firm EARL HOLLANDSWORTH, INC. Well Drilling

Address 5872 Snail Road Dayton 4, Ohio

Date August 24, 1955

Signed [signature]

526,500
(300'x3,000')
2,200 Sq.

# WELL LOG AND DRILLING REPORT

State of Ohio

OHIO WATER RESOURCES BOARD

Department of Public Works

553 E. Broad St., Columbus 15, Ohio

No. 5628

115

County Montgomery Township Harrison Section of Township or Lot Number Emry Park Flat

Owner F. Turrell Address 1514 Ome Avenue Dayton 4, Ohio

Location of property 4 Blocks East of U.S.State Route 25. North edge of Dayton, O. Along the Miami River.

| CONSTRUCTION DETAILS | PUMPING TEST |
|---|---|
| Casing diameter 1" Length of casing 38' | Pumping rate ____ G.P.M. Duration of test ____ h |
| Type of screen ____ Length of screen ____ | Drawdown ____ ft. Date ____ |
| Type of pump ____ | Developed capacity ____ |
| Capacity of pump ____ | Static level of completed well 15 ft. |
| Depth of pump setting ____ | Pump installed by ____ |

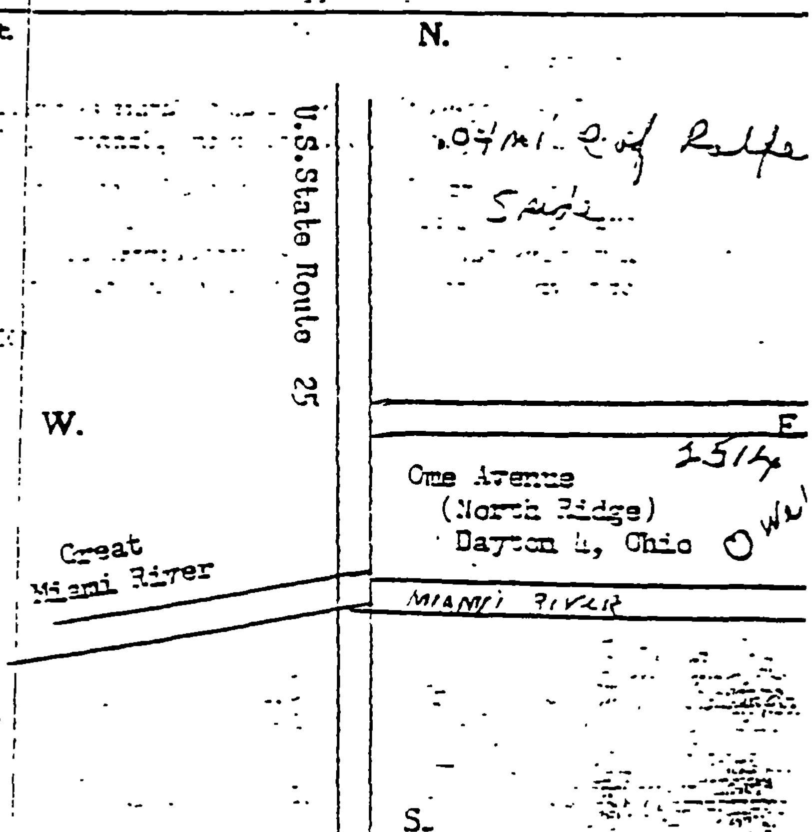
## WELL LOG

| Formations Sandstone, shale, limestone, gravel and clay | From | To |
|---|---|---|
| Top soil | 0 Feet | 2 Ft. |
| Gravel & Sand | 2 | 38 |

DIP Test
at aprox.
70 G.P.M.

## SKETCH SHOWING LOCATION

Locate in reference to numbered State Highways, St. Intersections, County roads, etc.




See reverse side for instructions

Drilling Firm EARL HOLLANDSWORTH ~~Well Drilling~~

Address 2535 Ome Avenue - North Ridge DAYTON, OHIO

Date June 15 1953

Signed Earl Hollandsworth

x =1,525,500
(1000x1000)
y =656,800

# WELL LOG AND DRILLING REPORT

State of Ohio
DEPARTMENT OF NATURAL RESOURCES
Division of Water
Columbus, Ohio

ORIGI

C L

№ 109453

County Montgomery Township Harrison Section of Township or Lot Number North Ridge

Owner James Franklin Welch Address 2704 Ome Avenue Dayton 4, Ohio

Location of property Lot 44 [illegible] Flat, North bank of the Great Miami River.

## CONSTRUCTION DETAILS

Casing diameter 4" Length of casing 54

Type of screen Length of screen

Type of pump

Capacity of pump

Depth of pump setting

## PUMPING TEST

Pumping rate G.P.M. Duration of test

Drawdown ft. Date

Developed capacity

Static level—depth to water 30

Pump installed by

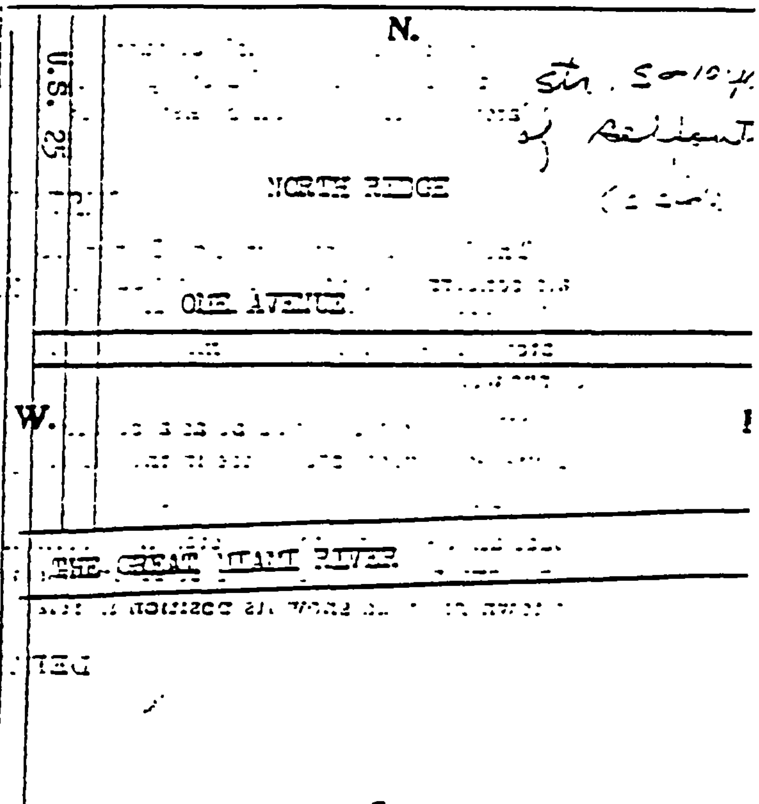
## WELL LOG

| Formations Sandstone, shale, limestone, gravel and clay | From | To |
|---|---|---|
| Top Soil | 0 Feet | 4 Ft. |
| Clay | 4 | 40 |
| Clay, some Gravel | 40 | 52 |
| Sand and Gravel, Water | 52 | 54 |

Dip test at approx. 10 G.P.M.

## SKETCH SHOWING LOCATION

Locate in reference to numbered State Highways, St. Intersections, County roads, etc.




Str. 50-10-4
[illegible]

See reverse side for instructions

Drilling Firm EARL HOLLANDSWORTH Well Drilling

Address 2538 Ome Avenue - North Ridge DAYTON, OHIO

Date 8-11-53

Signed Earl Hollandsworth

# WEL^ LOG AND DRILLING REPORT

ORIGINAL

B C

NO CARBON PAPER NECESSARY— SELF-TRANSCRIBING

State of Ohio
DEPARTMENT OF NATURAL RESOURCES
Division of Water
65 S. Front St., Rm. 815 Phone (614) 469-2646
Columbus, Ohio 43215

No. 398215

County Montgomery Township Harrison Section of Township

Owner Fred Tay Industries Address 2801 Ontario av.

Location of property Corner of Ontario av. and Fairfield av.

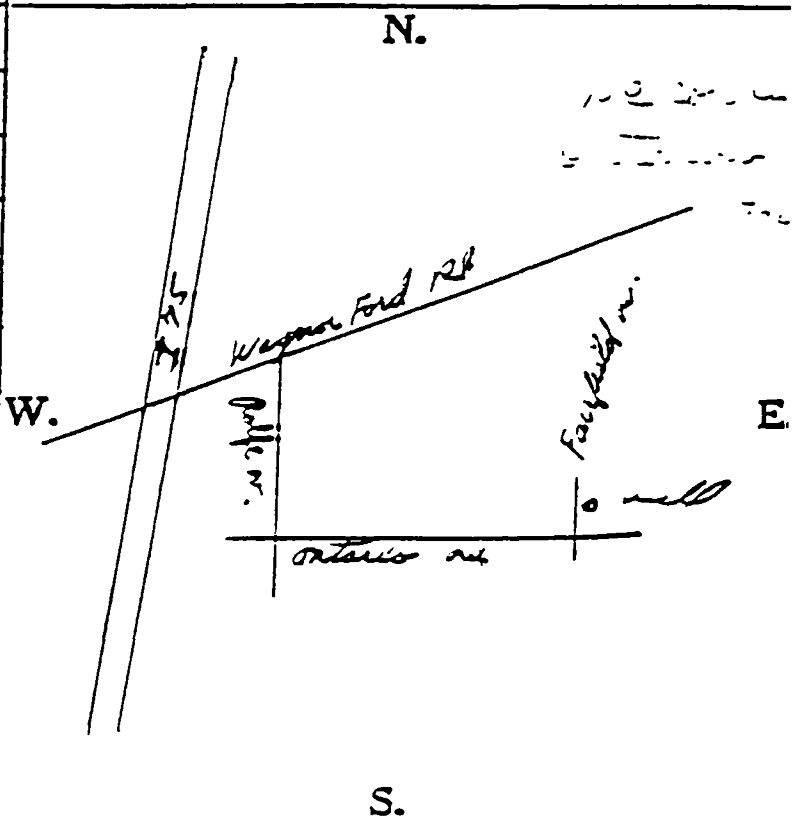
| CONSTRUCTION DETAILS | BAILING OR PUMPING TEST (Specify one by circling) |
|---|---|
| Casing diameter 5 5/8 Length of casing 77 | Test Rate 70 G.P.M. Duration of test hr |
| Type of screen Length of screen | Drawdown 50 ft. Date Sept 69 |
| Type of pump | Static level-depth to water 21 |
| Capacity of pump | Quality (clear, cloudy, taste, odor) |
| Depth of pump setting | |
| Date of completion | Pump installed by Owner |

WELL LOG*

| Formations Sandstone, shale, limestone, gravel and clay | From | To |
|---|---|---|
| Dry gravel | 0 Feet | 22 Ft. |
| Some water | 22 | 23 |
| Dry gravel | 23 | 52 |
| Sand | 52 | 75 |
| Gravel water | 75 | 77 |

SKETCH SHOWING LOCATION

Locate in reference to numbered State Highways, St. Intersections, County roads, etc.




Drilling Firm Burns Well Drilling Date Aug 24 69

Address Tipp City Signed Donald Bremer

*If additional space is needed to complete well log, use next consecutive numbered form

# WELL LOG AND DRILLING REPORT

State of Ohio
DEPARTMENT OF NATURAL RESOURCES
Division of Water
Fountain Square
Columbus, Ohio 43224

NO CARBON PAPER NECESSARY— SELF-TRANSCRIBING

T11

599538

COUNTY Montgomery TOWNSHIP Mad River SECTION OF TOWNSHIP 31

OWNER Kathleen Kinsinger ADDRESS 2907 Old Troy Pike

LOCATION OF PROPERTY Same

## CONSTRUCTION DETAILS

Casing diameter 6 Length of casing 120

Type of screen Length of screen

Type of pump Sub

Capacity of pump 10 GPM

Length of pump setting 100

Date of completion 6 Dec. 1981

## BAILING OR PUMPING TEST
(specify one by circling)

Test rate 10 gpm Duration of test 10

Drawdown 4 ft Date 4 Dec 19

Static level (depth to water) 52'

Quality (clear, cloudy, taste, odor) Clear

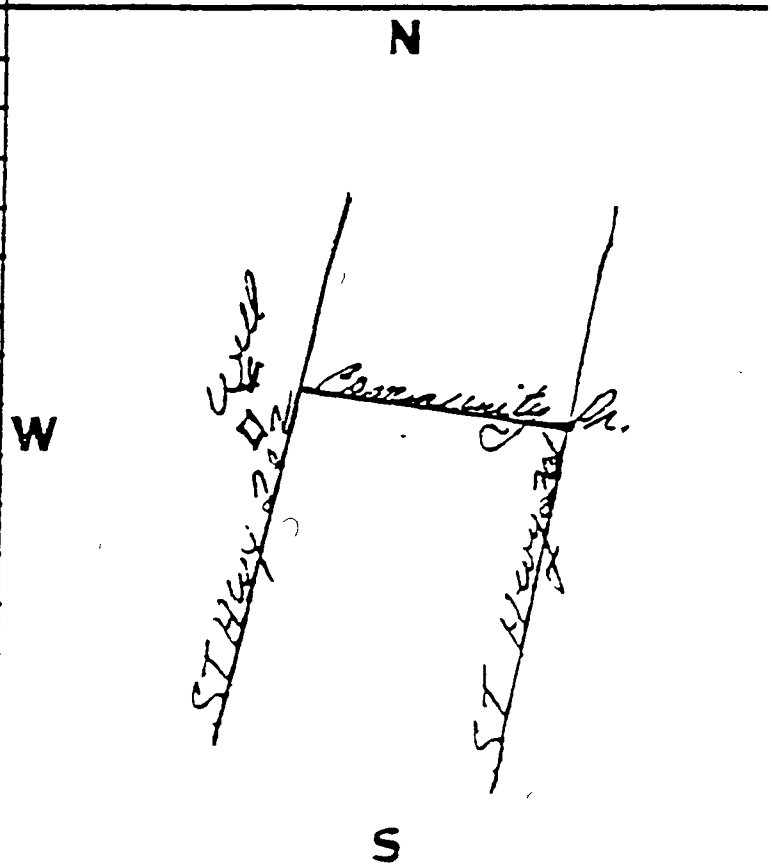
Pump installed by S C Pattison

## WELL LOG*

| Formations: sandstone, shale, limestone, gravel, clay | From | To |
|---|---|---|
| Top soil | 0 ft | 4 ft |
| Dry Sand & Gravel | 4 | 52' |
| Sand | 52 | 80 |
| Sand & Gravel | 80 | 120 |

## SKETCH SHOWING LOCATION

Locate in reference to numbered state highways, street intersections, county roads, etc.




DRILLING FIRM Pattison Well Co. DATE 6 Dec 1981

ADDRESS 5901 S Dixie Dr SIGNED S C Pattison

*If additional space is needed to complete well log, use next consecutive numbered form.

# WEL[illegible] LOG AND DRILLING REP[illegible]RT

ORIGIN

NO CARBON PAPER NECESSARY - SELF-TRANSCRIBING

State of Ohio
DEPARTMENT OF NATURAL RESOURCES
Division of Geological Survey
Fountain Square
Columbus, Ohio 43224 Phone (614) 466-5344

478848

COUNTY [illegible]ontgomery TOWNSHIP [illegible]ad River SECTION OF TOWNSHIP OR LOT NUMBER 31

OWNER [illegible] Carl [illegible] ADDRESS 2825 Troy Pike, Dayton, 4540[illegible]

LOCATION OF PROPERTY Troy Pike Route 202

## CONSTRUCTION DETAILS

Casing diameter [illegible] Length of casing [illegible]

Type of screen ______ Length of screen ______

Type of pump [illegible] H.P. Submersible

Capacity of pump 7 [illegible]

Depth of pump setting 6[illegible] ft

Date of completion [illegible]

## BAILING OR PUMPING TEST
(specify one by circling)

Test rate 2[illegible] gpm Duration of test 1

Drawdown [illegible] ft Date 10-7-76

Static level (depth to water) [illegible]

Quality (clear, cloudy, taste, odor) Clear

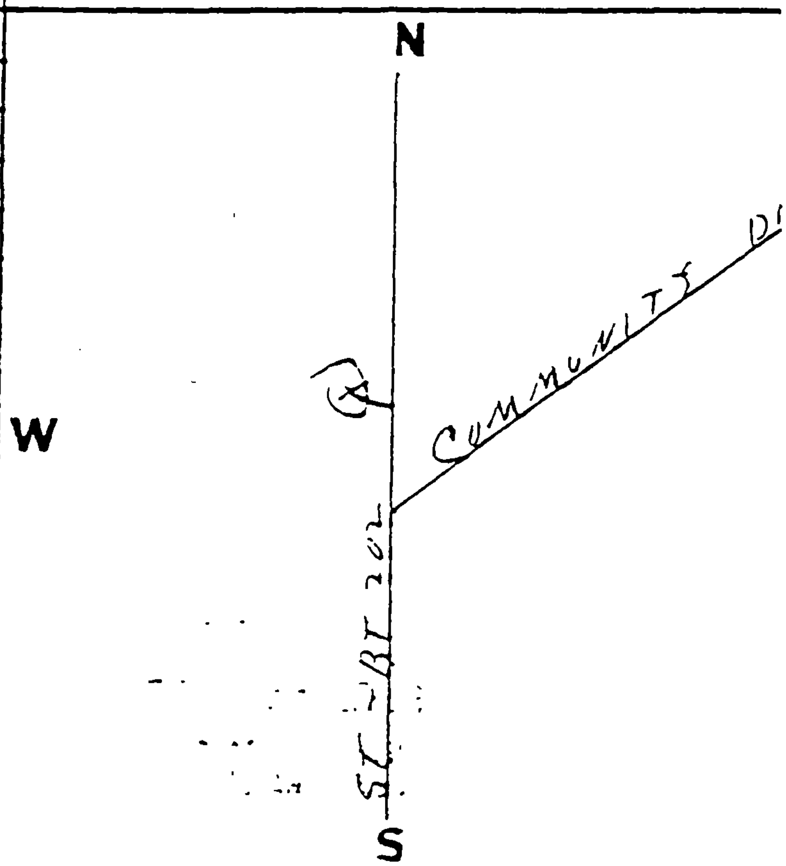
Pump installed by Scott Well [illegible] Co

## WELL LOG*

| Formations: sandstone, shale, limestone, gravel, clay | From | To |
|---|---|---|
| Top Soil | 0 ft | 3 ft |
| [illegible] Gravel | 3 | 30 |
| [illegible] Hard [illegible] | 30 | 3[illegible] |
| Water Gravel | 3[illegible] | [illegible] |

## SKETCH SHOWING LOCATION

Locate in reference to numbered state highways, street intersections, county roads, etc.




DRILLING FIRM Scott Well & Pump Co DATE 10-7-7[illegible]

ADDRESS 5659 [illegible] Road, Dayton SIGNED Mrs O [illegible] Scott

*If additional space is needed to complete well log, use [illegible]

# WELL LOG AND DRILLING REPORT

ORIGINAL

State of Ohio
DEPARTMENT OF NATURAL RESOURCES
Division of Geological Survey
Fountain Square
Columbus, Ohio 43224 Phone (614) 466-5344

—NO CARBON PAPER NECESSARY— SELF-TRANSCRIBING

478823

COUNTY Montgomery TOWNSHIP Mad River SECTION OF TOWNSHIP OR LOT NUMBER 3½

OWNER William Witt ADDRESS 2503 Troy Pike Dayton

LOCATION OF PROPERTY ¼ mile south of Community Dr. on Troy Pike

| CONSTRUCTION DETAILS | |
|---|---|
| Casing diameter | 6" |
| Length of casing | 73 ft. |
| Type of screen | |
| Length of screen | |
| Type of pump | submergible |
| Capacity of pump | ½ h.p. |
| Depth of pump setting | 65 ft |
| Date of completion | 10-10-75 |

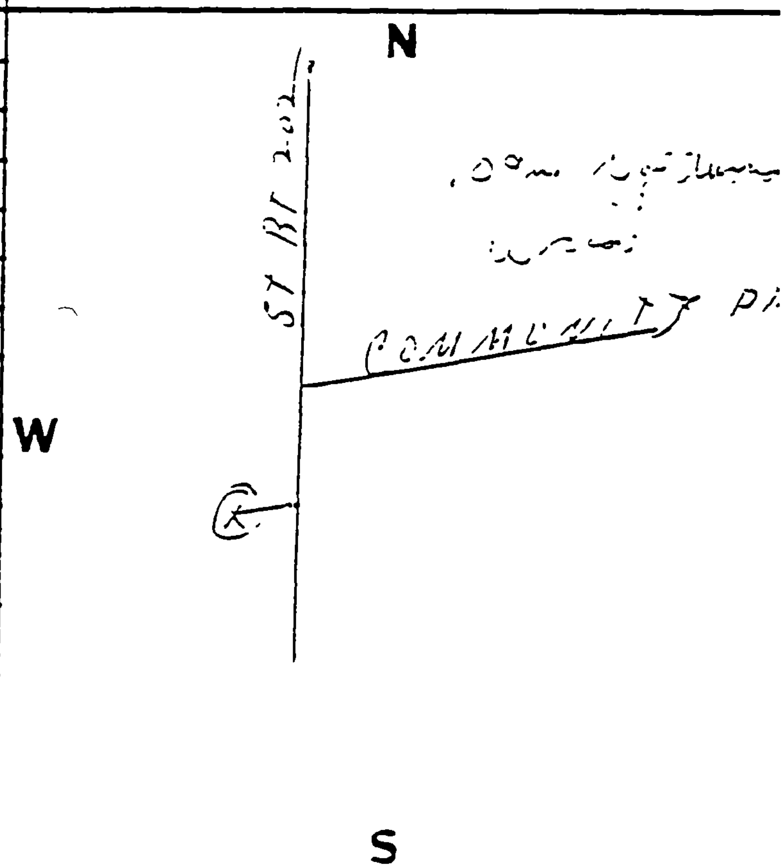
| BAILING OR PUMPING TEST (specify one by circling) | |
|---|---|
| Test rate | 25 gpm |
| Duration of test | |
| Drawdown | 4 ft |
| Date | 10-9-75 |
| Static level (depth to water) | 37 |
| Quality (clear, cloudy, taste, odor) | clear |
| Pump installed by | Scott Well & Pump Co. |

## WELL LOG*

| Formations: sandstone, shale, limestone, gravel, clay | From | To |
|---|---|---|
| topsoil | 0 ft | 5 ft |
| dry gravel | 5 | 27 |
| hardpan | 27 | 32 |
| mucky sand & Gravel | 32 | 40 |
| water gravel | 40 | 73 |

## SKETCH SHOWING LOCATION

Locate in reference to numbered state highways, street intersections, county roads, etc.




DRILLING FIRM Scott Well & Pump Co. DATE 10-10-75

ADDRESS 5850 Brantford Rd. SIGNED [signature]

County Permit No. ______ 1

# WELL LOG AND DRILLING REPORT

State of Ohio
DEPARTMENT OF NATURAL RESOURCES
Division of Water
Fountain Square
Columbus, Ohio 43224

NO CARBON PAPER NECESSARY — SELF-TRANSCRIBING

ORIGINAL

551557

COUNTY Montgomery TOWNSHIP Mad River SECTION OF TOWNSHIP 36

OWNER John Sullivan ADDRESS 2627 Old Troy Pike

LOCATION OF PROPERTY ______

## CONSTRUCTION DETAILS

Casing diameter 6" Length of casing 72'

Type of screen ______ Length of screen ______

Type of pump Submergible

Capacity of pump 10

Depth of pump setting 73'

Date of completion 4-30-80

## BAILING OR PUMPING TEST
(specify one by circling)

Test rate 10 gpm Duration of test 1 one

Drawdown 20 ft Date 4-24-80

Static level (depth to water) 40

Quality (clear, cloudy, taste, odor)

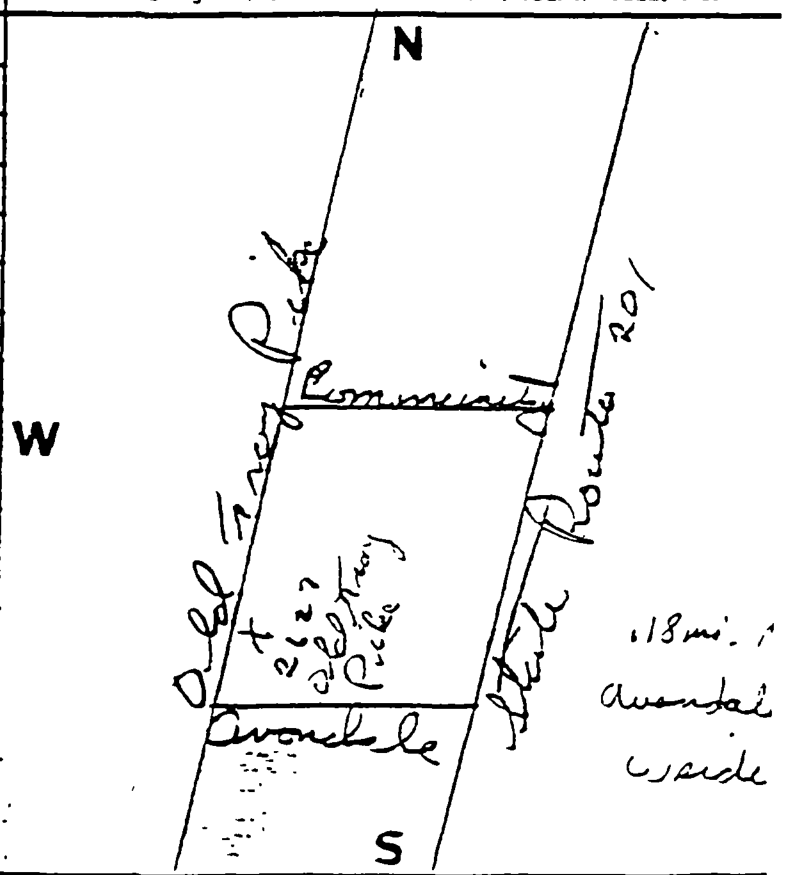
Pump installed by Jenkins Pump Ser.

## WELL LOG*

| Formations: sandstone, shale, limestone, gravel, clay | From | To |
|---|---|---|
| Top Clay | 0 ft | 5 ft |
| Dry Gravel | 5 | 45 |
| Green Clay | 45 | 47 |
| Sand | 47 | 56 |
| Green Clay | 56 | 64 |
| Fine Sand | 64 | 70 |
| Water Sand | 70 | 78 |

## SKETCH SHOWING LOCATION

Locate in reference to numbered state highways, street intersections, county roads, etc.




DRILLING FIRM Jenkins Pump Service DATE 4-30-80

ADDRESS 1988 Troutwood Rd SIGNED John P. Jenkins

* If additional space is needed to complete well log, use next consecutive numbered form.

# WELL-LOG AND DRILLING REPORT

State of Ohio
DEPARTMENT OF NATURAL RESOURCES
Division of Water
1562 W. First Avenue
Columbus, Ohio 43212

PLEASE USE PENCIL OR TYPEWRITER
DO NOT USE INK

No. 33246

County Montgomery Township Mad River Section of Township 3

Owner Robert Wilson Address 2121 Troy St.

Location of property 2121 Troy St

| CONSTRUCTION DETAILS | |
|---|---|
| Casing diameter 5" | Length of casing 60 |
| Type of screen | Length of screen |
| Type of pump | |
| Capacity of pump | |
| Depth of pump setting | |
| Date of completion | |

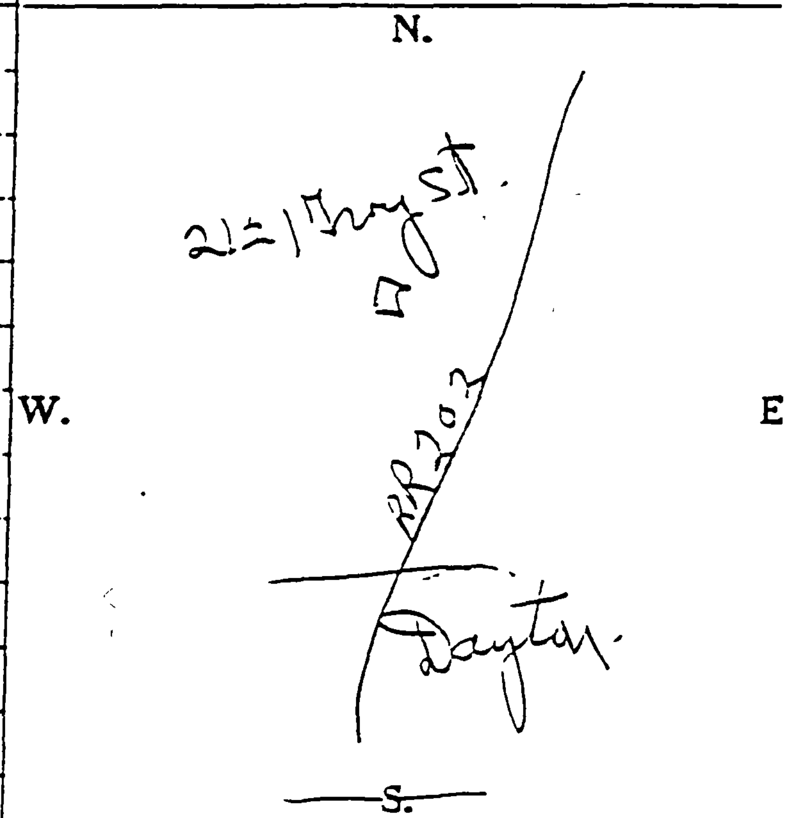
| BAILING OR PUMPING TEST | |
|---|---|
| Pumping Rate 12 G.P.M. | Duration of test 2 |
| Drawdown 5 ft. | Date June 9 1965 |
| Static level-depth to water 21.5 | |
| Quality (clear, cloudy, taste, odor) | |
| Pump installed by | |

## WELL LOG*

| Formations Sandstone, shale, limestone, gravel and clay | From | To |
|---|---|---|
| Clay | 0 Feet | 4 Ft. |
| Gravel & Sand | 4 | 38 |
| Clay | 38 | 59 |
| Gravel | 59 | 60 |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |

## SKETCH SHOWING LOCATION

Locate in reference to numbered State Highways, St. Intersections, County roads, etc.




See reverse side for instructions

Drilling Firm CLAY P. GARRISON
Address WELL CONTRACTOR
3901 S. DIXIE DR.
DAYTON 3, OHIO

Date June 10 1965
Signed Clay P. Garrison

*If additional space is needed to complete well log...

# WELL LOG AND DRILLING REPORT

State of Ohio
DEPARTMENT OF NATURAL RESOURCES
Division of Water
1562 W. First Avenue
Columbus, Ohio

PLEASE USE PENCIL OR TYPEWRITER DO NOT USE INK

No. 248078

County MONTHOMERY Township MADRIVER Section of Township 36

Owner MIKE HECK Address 2216 TROY ST DAYTO

Location of property

| CONSTRUCTION DETAILS | | BAILING OR PUMPING TEST | |
|---|---|---|---|
| Casing diameter 5 5/8 | Length of casing 70 | Pumping rate 20 G.P.M. | Duration of test |
| Type of screen | Length of screen | Drawdown 5 ft. | Date Dec 12 - 60 |
| Type of pump | | Developed capacity 1800 | |
| Capacity of pump | | Static level—depth to water 35 | |
| Depth of pump setting | | Pump installed by | |
| Date of completion | | | |

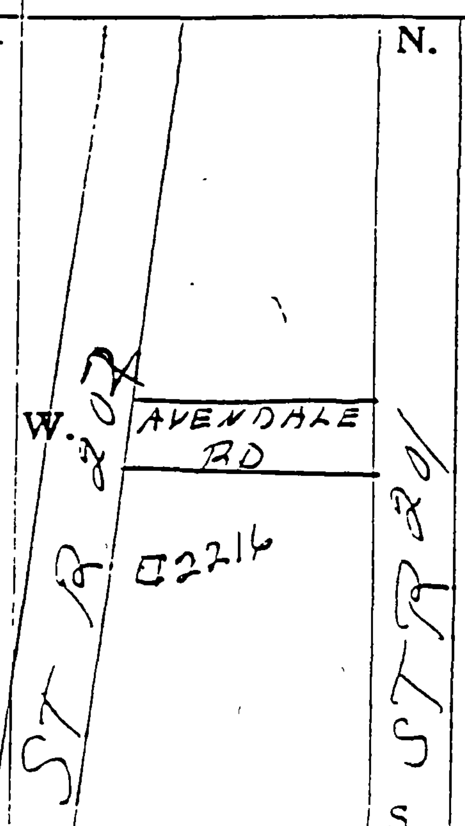
## WELL LOG

| Formations Sandstone, shale, limestone, gravel and clay | From | To |
|---|---|---|
| CLAY | 0 Feet | 8 Ft. |
| BCLA + GRAVEL | 8 | 32 |
| BCLAY & SAND | 35 | 54 |
| B CLAY | 54 | 65 |
| GRAVEL | 65 | 70 |

200 feet South of Avendale Rd on St R 202 East side

## SKETCH SHOWING LOCATION

Locate in reference to numbered State Highways, St. Intersections, County roads, etc




See reverse side for instructions

Drilling Firm

Address

Date Dec 12 - 60

Signed John Brenney

# WELL LOG AND DRILLING REPORT

State of Ohio
DEPARTMENT OF NATURAL RESOURCES
Division of Water
1562 W. First Avenue
Columbus, Ohio

PLEASE USE PENCIL OR TYPEWRITER
DO NOT USE INK

No. 248

County MONTGOMERY Township Mad River Section of Township 36

Owner A. G. BECHIE Address 2614 TROY ST

Location of property DAYTON OHIO

## CONSTRUCTION DETAILS

Casing diameter 5 5/8 Length of casing 83

Type of screen — Length of screen

Type of pump 3 Submersible

Capacity of pump 600

Depth of pump setting 70

Date of completion May 20-61

## BAILING OR PUMPING TEST

Pumping rate 30 G.P.M. Duration of test

Drawdown 10 ft. Date May 20-61

Developed capacity

Static level—depth to water 30

Pump installed by JOHN BRENNER

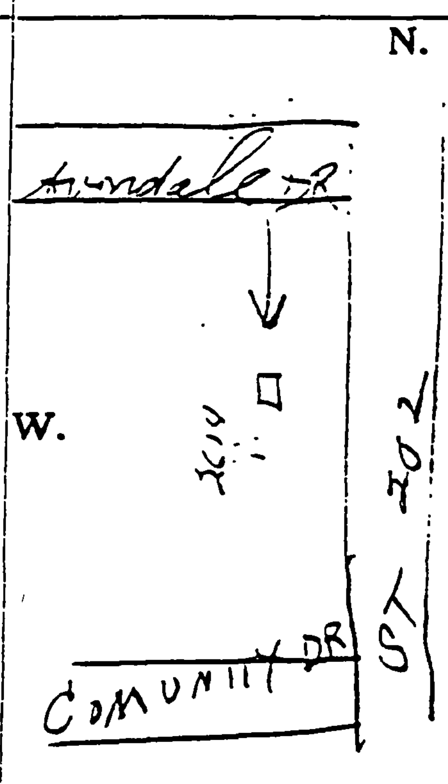
## WELL LOG

| Formations Sandstone, shale, limestone, gravel and clay | From | To |
|---|---|---|
| B CLAY | 0 Feet | 50 Ft. |
| GRAVEL | 50 | 50 |
| B CLAY | 50 | 59 |
| SAND | 59 | 80 |
| GRAVEL | 80 | 83 |

600 feet North of Avondale DR

## SKETCH SHOWING LOCATION

Locate in reference to numbered State Highways, St. Intersections, County roads, et




.16 mi. N. Avondale e side

See reverse side for instructions

Drilling Firm

Address

Date May 20-61

Signed John H Brenner

# WELL LOG AND DRILLING REPORT

State of Ohio
DEPARTMENT OF NATURAL RESOURCES
Division of Water
Columbus, Ohio

No 128409

County Montg Township Madriver Section of Township or Lot Number 36

Owner Donald Takacs Address

Location of property 112 Avindale Ave

| CONSTRUCTION DETAILS | PUMPING TEST |
|---|---|
| Casing diameter 4 1/4" Length of casing 80' | Pumping rate G.P.M. Duration of test |
| Type of screen Length of screen | Drawdown ft. Date |
| Type of pump | Developed capacity |
| Capacity of pump | Static level—depth to water |
| Depth of pump setting | Pump installed by |

WELL LOG

| Formations Sandstone, shale, limestone, gravel and clay | From | To |
|---|---|---|
| Clay | 0 Feet | 9 Ft. |
| Gravel & sand | 9 | 35 |
| Clay | 35 | 78 |
| gravel | 78 | 80 |

SKETCH SHOWING LOCATION

Locate in reference to numbered State Highways, St. Intersections, County roads, e

N.

W.

S.

See reverse side for instructions

Drilling Firm A E Lotts & son

Address 2413 Valley st

Date June 11 / 54

Signed A E Lotts

OHIO
5

# WELL LOG AND DRILLING REPORT

State of Ohio
DEPARTMENT OF NATURAL RESOURCES
Division of Water
1500 Dublin Road
Columbus, Ohio

No. 218833

County [illegible] Township [illegible] Section of Township [illegible]

Owner [illegible] Address [illegible]

Location of property [illegible]

| CONSTRUCTION DETAILS | BAILING OR PUMPING TEST |
|---|---|
| Casing diameter 5 1/2 Length of casing | Pumping rate [illegible] G.P.M. Duration of test 1 hr |
| Type of screen Length of screen | Drawdown ft. Date |
| Type of pump | Developed capacity |
| Capacity of pump | Static level—depth to water ft |
| Depth of pump setting | Pump installed by |
| Date of completion | |

## WELL LOG

| Formations Sandstone, shale, limestone, gravel and clay | From | To |
|---|---|---|
| top soil | 0 Feet | 10 Ft. |
| Gravel | 34 | 55 |
| Sand | 55 | 65 |
| Blue mud | 65 | 90 |
| Gravel | 90 | |

RECEIVED
FEB 1959
[illegible]

## SKETCH SHOWING LOCATION

Locate in reference to numbered State Highways, St. Intersections, County roads, etc.

N.

W.

E.

S.

See reverse side for instructions

Drilling Firm [illegible] Date [illegible] 1959

Address [illegible] Signed [illegible]

# WEL~ LOG AND DRILLING REP~T

State of Ohio
DEPARTMENT OF NATURAL RESOURCES
Division of Water
1562 W. First Avenue
Columbus 12, Ohio

PLEASE USE PENCIL
OR TYPEWRITER
DO NOT USE INK

Nº 29738

County Montgomery Township Mad River Section of Township

Owner Michael Pandizk Address 120 Avondale Avenue, Dayton 14, Ohi

Location of property 120 Avondale Avenue, Dayton, Ohio

| CONSTRUCTION DETAILS | BAILING ~~OR PUMPING~~ TEST |
|---|---|
| Casing diameter 5-5/8" Length of casing 74 | Pumping Rate 20 G.P.M. Duration of test 1 hr |
| Type of screen RED BRASS Length of screen 4' | Drawdown 2 ft. Date 5/24/63 |
| Type of pump REDI-CAPTON ½ HP SUBMERSIBLE | Static level-depth to water 43 |
| Capacity of pump 650 GPH | Quality (clear, cloudy, taste, odor) MURKY QUALITY. |
| Depth of pump setting 70 FT | WILL CLEAR WITH PUMPING |
| Date of completion May 24, 1963 | Pump installed by OWNER |

## WELL LOG

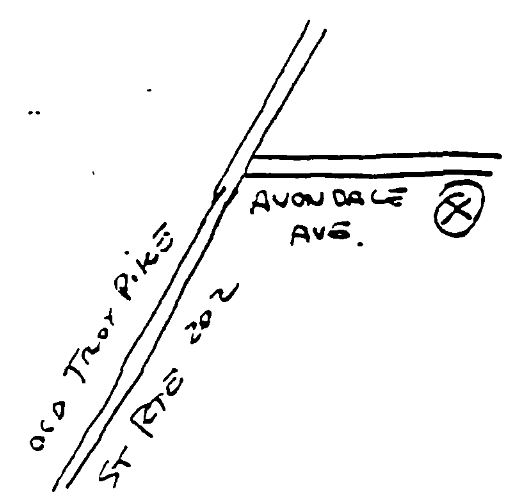
| Formations Sandstone, shale, limestone, gravel and clay | From | To |
|---|---|---|
| clay | 0 Feet | 5 Ft. |
| dry gravel | 5 | 50 |
| lomey sanc | 50 | 70 |
| sand-water | 70 | 77 |

## SKETCH SHOWING LOCATION

Locate in reference to numbered State Highways, St. Intersections, County roads, etc.

N.

W.




E.

S.

See reverse side for instructions

Drilling Firm Moody's of Dayton, Inc. Date May 27, 1963

Address P.O. Box 155, Vandalia, Ohio Signed Donald R [illegible]

X = 1,531,600
(2000 x 2000)
Y = 653,300 – S

# WELL LOG AND DRILLING REPORT

State of Ohio
DEPARTMENT OF NATURAL RESOURCES
Division of Water
Columbus, Ohio

№ 129065

County Montgomery Township Mad River Section of Township or Lot Number 3½

Owner William H. Olson Address 110 Avondale Drive Dayton 4, Ohio

Location of property East Off Troy pike about 1/8 of a Mile on Avondale Dr.

## CONSTRUCTION DETAILS

Casing diameter 6" Length of casing 81 Ft.

Type of screen ________ Length of screen ________

Type of pump ________

Capacity of pump ________

Depth of pump setting ________

## PUMPING TEST

Pumping rate ________ G.P.M. Duration of test ________

Drawdown ________ ft. Date April 9, 1954

Developed capacity ________

Static level—depth to water 4?

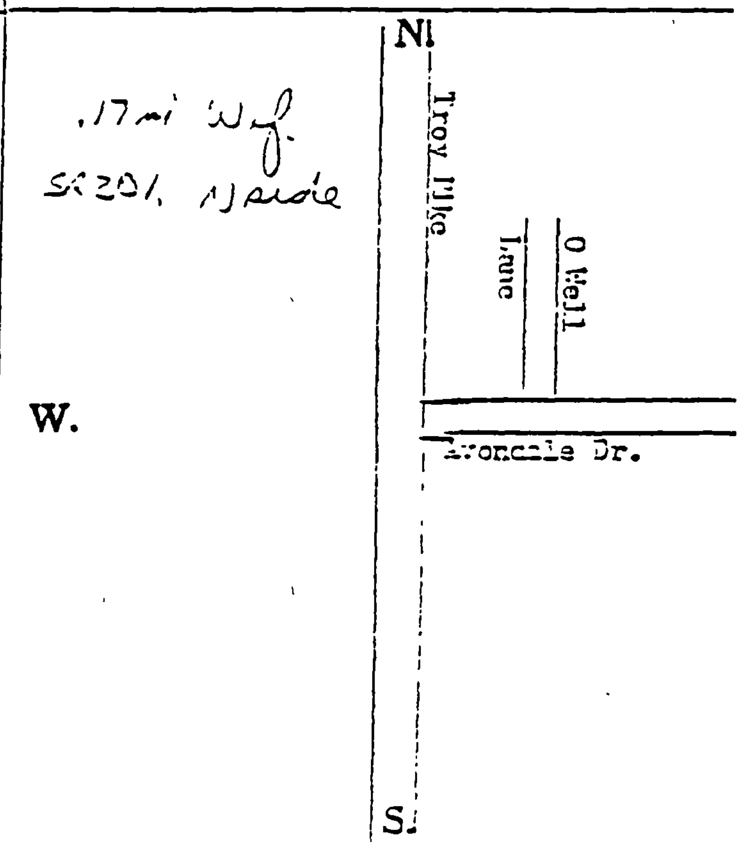
Pump installed by ________

## WELL LOG

| Formations Sandstone, shale, limestone, gravel and clay | From | To |
|---|---|---|
| Top Soil | 0 Feet | 5 Ft. |
| Gravel | 5 | 35 |
| Clay & Gravel | 35 | 50 |
| Gravel & Water | 50 | 81 |
| Dip Test at Approx. 10 G.P.M. | | |

## SKETCH SHOWING LOCATION

Locate in reference to numbered State Highways, St. Intersections, County roads, e




See reverse side for instructions

Drilling Firm EARL HOLLANDSWORTH Well Drilling

Address ~~Ome Avenue~~ North Ridge DAYTON, OHIO

Date April 9, 1954

Signed Earl Hollandsworth

# Dayton Thermal Products Division
# Site Activity Summary

**Prepared for:**

Dayton Thermal Products Division
Acustar, Inc.
Dayton OH

**Prepared by:**

Clean Tech
2700 Capitol Trail
Newark DE 19711

**April 1993**

# Table of Contents

# Dayton Thermal Products Division
# Site Activity Summary

## 1.0 INTRODUCTION

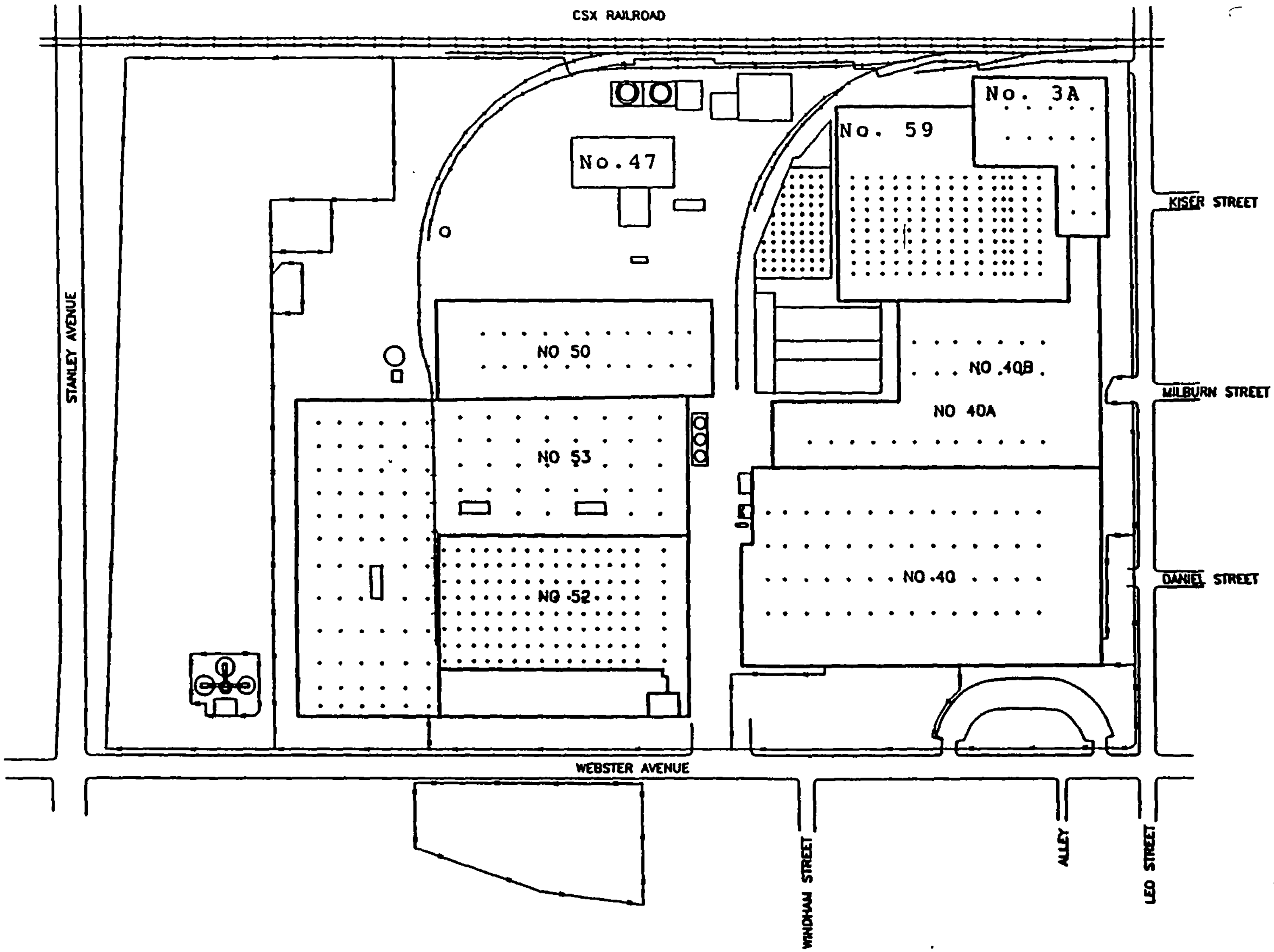
The Dayton Thermal Products Plant (the Plant) requested Clean Tech to prepare this summary report for their facility in Dayton, Ohio. This report focuses on the environmental activities which followed the discovery of VOCs and TPH in soils under the floor during demolition of the old Maxwell Complex. These buildings were replaced with a new manufacturing building. About five feet of clay soil was excavated in order to meet higher floor strength requirements for the new building. Also included are VOC remediation efforts on excavated soils to date, remediation plans to treat TPH remaining in the excavated soils, and future plans for a site-wide hydrogeological study.

This report is a compilation of information and data gathered from February 1991 through November 1992. A majority of this information was assembled by Mathes/Burlington, Columbia, Illinois.

### 1.1 <u>Facility Description</u>

The plant is located at 1600 Webster Street in Dayton, Ohio The facility contains over 1.3 million square feet and is located on approximately 60 acres A site plan is shown in Figure 1. Manufacturing began at the site in 1907 with the production of Maxwell cars. Past plant operations have included; manufacture of air conditioning equipment and furnaces, tubing production, plastic moldings and military paraphernalia. Chrysler purchased the facility in 1936 The plant primarily manufactures, assembles, and finishes heat exchangers and air conditioning components for motor vehicles

The facility is comprised of eight manufacturing buildings, a powerhouse, wastewater treatment plant, and incidental storage buildings Prior to its demolition, the antiquated Maxwell Complex was used as a warehouse for more than a decade Demolition began in October 1990 and the new Building #59 and parking lot were completed about one year later, in the fall of 1991 The latter now stands where the Maxwell Complex was formerly located (See Figure 1)




CLEANTECH

**Burlington Environmental Inc.**

SITE PLAN

ACUSTAR
DAYTON, OHIO
124585

FIGURE 1

## 1.2 Demolition of Maxwell Complex

Acustar completed an extensive environmental testing program during the demolition of the Maxwell Complex and prior to the construction of Building #59 The investigation included a review of existing reports and data and an evaluation of soil conditions.

Miami Geological Services, Inc., a small local firm, was initially retained to oversee construction activities and to provide for air and soil sampling during the demolition of the Maxwell complex. When the scope and complexity of environmental concerns increased during demolition, the Plant decided to hire the services of a larger company, Mathes/Burlington, to oversee the environmental concerns related to construction activities. The field activities performed were quite extensive and included the evaluation of:

- Soil conditions in and around existing structures which would be removed during construction. This included soils around such areas as sewer lines, pipelines, sumps, storage pads and storage areas, etc.,
- Soil conditions in areas to be excavated. This included the foundation areas, the column piers, and adjacent paved surfaces ,
- Soils remaining in-place in selected areas such as the clay soil used as part of the foundation material,
- Soil stockpiled on-site for disposal or remediation; and
- Slabs of concrete from the demolition of the foundation of the Maxwell complex

The investigation of the soils from the Maxwell Complex included:

- Test boreholes in areas which were excavated for strip foundations;
- Test boreholes in areas which were excavated for column piers;
- Soil sample testing after excavation of sewer lines, sumps, catch basins, and oil/water separators

Twenty (20) soil samples were collected from the area which was excavated for the strip foundation. These twenty soil samples were composited into five samples. These samples were analyzed for Toxicity Characteristic Leaching Procedures (TCLP) test for metals, volatiles, semi-volatiles, and polychlorinated biphenyls (PCBs)

Fifty-six (56) boreholes were drilled in the areas to be excavated for the column piers. These boreholes were four to six feet in depth. These samples were analyzed for total metals (chromium, lead, and zinc), volatile organic compounds (VOCs), and total petroleum hydrocarbons (TPH). A composite sample from each borehole was analyzed for these parameters.

Additional samples were taken from areas which were excavated for sewer lines, sumps, catch basins, and oil/water separators. The analytical results from soil samples taken within the foundation area indicated above detection levels for certain VOCs and TPH. The volatiles which were detected include; trichloroethene (TCE), tetrachloroethane (PCE), 1,1,1-trichloroethane (TCA), 1,1-dichloroethene (DCE), and 1,2-dichloroethene. Attempts were made to correlate the regulated compounds with a process or source. No correlations or sources of these materials could be found.

## 1.3 Soil Stockpile Construction

As a result of the soil investigation and subsequent excavation of soils, different soil stockpiles were constructed. The stockpiles were created according to the primary compound identified during analysis. Stockpiles soils were segregated to facilitate potential future remediation. The data collected as part of an environmental assessment indicated that the four stockpiles should be constructed as follows.

- Stockpile 1, the "Clean" Pile
  Soil in this pile, the second largest, appeared to be relatively clean and free of visible stains. Field measurements indicated little or no VOCs. The soil volume is approximately 7,100 cubic yards Analytical data indicated this stockpile contained less than 40 mg/kg TPH and less than 50 ug/kg VOCs. It is located several hundred feet north of Building #47

- Stockpile 2, the "TPH" Pile
  This, the largest stockpile, was visibly stained and primarily contained TPH ranging from 40 to 3,500 mg/kg. Its volume is approximately 10,800 cubic yards. The pile is located on the northeast corner of Building #47

- Stockpile 3, the "VOC" Pile

  This stockpile was visibly free of stains but contained higher levels of VOCs. Analysis indicated VOC levels up to 10,000 ug/kg. Its volume is approximately 2,800 cubic yards. It is located on the northwest corner of Building #47.

- Stockpile 4, the Fourth Pile

  Construction of this, the smallest pile, was not completed until some time after the above three stockpiles. The pile was first analyzed for VOC and TPH by Clean Tech in November 1992. It was found to contain TPH greater than 105 mg/kg. It is basically comprised of soils excavated from the new building's parking lot which was completed after the new building. Its volume is approximately 1,800 cubic yards. This pile is just east of Building #47

## 2.0 REMEDIATION BY VAPOR EXTRACTION

Because of the presence of varying levels of VOCs and TPH in the footprint soils, remediation of these soils was anticipated and various methods were studied prior to excavation. It had been determined that the soils were non-hazardous. This was concluded because (1) after diligent efforts, the VOCs could not be traced to a known source, and (2) the soils were tested for characterization (TCLP analysis) and found to be non-hazardous.

Mathes proposed and the Plant agreed to install aboveground vapor extraction systems for the Clean, TPH, and VOC stockpiles. This appeared to be the most cost-effective approach to remediate the soils for VOCs. Preparations were made to accommodate the soon-to-arrive soils. Polyethylene sheeting was also placed over each pile when it was completed.

For the three stockpiles, the Clean, TPH, and VOC, a series of four inch perforated pipes were appropriately spaced and installed the entire length of the stockpiles. These pipes were covered with geotextile.

Because of the low VOC levels in the Clean stockpile, this pile was allowed to aspirate naturally without blowers.

For the TPH and VOC stockpiles, however, the vent pipes were tied into a manifold system which, in turn, was connected to regenerative blowers to extract the VOCs Sampling ports were installed after the blowers to monitor the exhaust gases Preparations for vapor extraction of the stockpiles were completed on April 19, 1991 Before start-up, however, a pilot study was conducted to optimize operating parameters and gather information on VOC emissions for Agency submittal. On April 30, 1991, RAPCA granted approval to operate the system on a full-time basis. Throughout the vapor extraction treatment period, VOC emissions were monitored. As anticipated, VOC concentrations decreased substantially with time When the point of diminishing returns was finally reached and negligible amounts of VOCs were detected in the exhaust stream, the stockpiles were then sampled and analyzed.

# 3.0 SOIL SAMPLING & ANALYTICAL RESULTS

## 3.1 Sampling & Analytical Procedures

During the week of July 29, 1991, after three months of vapor extraction, the stockpiles were sampled and analyzed to evaluate the effectiveness of the remediation program. U.S. EPA Guidelines were followed to determine a suitable grid pattern for sampling. The following grid intervals were selected:

| Stockpile | Sampling Grid Interval (feet) |
|---|---|
| Clean | 41 |
| TPH | 39 |
| VOC | 32 |

The samples were collected using standard split-spoon procedures, followed by hollow-stem augering. All material was screened with an HNU meter and composited for analysis. All three stockpiles were analyzed for VOCs using Method 8240 The TPH stockpile was also analyzed using Method 418.1.

## 3.2 Clean Stockpile

A total of 15 samples were analyzed from this stockpile. Individual VOCs were all less than 100 ug/kg. The VOCs detected were trichloroethene (TCE), 1,1,1-trichloroethane (TCA), tetrachloroethene (PCE), ethyl benzene, xylene, and chloroform

- No VOCs were detected in five of fifteen samples;
- In six other samples, only TCE, from 8 3 ug/kg to 54 ug/kg, was detected;
- In one sample, 64 ug/kg TCE and 12 ug/kg TCA were detected, and
- In the last three samples, TCE (49, 52, and 46 ug/kg, respectively), TCA (14, 9 8, and 96 ug/kg, respectively), and PCE (13, 21, and 9 8 ug/kg, respectively) were detected

## 3.3 TPH Stockpile

A total of 15 samples were analyzed from this stockpile. The samples were analyzed for VOCs and TPH. The VOCs detected include: TCE, TCA, PCE, and chloroform. All samples, except one, were below 100 ug/kg. One sample contained 130 ug/kg of TCE. The TPH results, however, showed that the TPH stockpile still contained concentrations in excess of the Ohio EPA's limit of 105 mg/kg. Concentrations ranged from 17 5 mg/kg to 6,170 mg/kg in this pile.

- No VOCs were detected in three samples;
- Only TCE, ranging in concentration from 8.6 ug/kg to 30 ug/kg, was detected in seven samples;
- TCE (130 and 71 ug/kg, respectively) and TCA (6.9 and 8 1 ug/kg, respectively) were detected in two samples;
- TCE (86 ug/kg) and chloroform (6.1 ug/kg) were detected in one sample;
- TCE (71 ug/kg), TCA (8 ug/kg), and chloroform (8 9 ug/kg) were detected in one sample;
- TCE (67 ug/kg), PCE (16 ug/kg), and chloroform (9 4 ug/kg) were detected in one sample.

## 3.4 VOC Stockpile

18 samples were analyzed for VOCs from this stockpile. All VOCs in this pile were below 100 ug/kg. The VOCs detected included; TCE, TCA, PCE, ethyl benzene, xylenes, and chloroform.

- No VOCs were detected in seven samples;
- TCE ranging in concentration from 4.34 ug/kg to 41 ug/kg, was detected in five samples;
- PCE (9 ug/kg) was detected in one sample;

- TCE (24 ug/kg), TCA (6 ug/kg), ethylbenzene (6.2 ug/kg), xylenes (38 ug/kg), and chloroform (12 ug/kg) were detected in one sample;

- TCE (4.3 ug/kg), ethylbenzene (2 ug/kg), and xylenes (94 ug/kg) were detected in one sample;

- TCE (54 ug/kg), TCA (17 ug/kg), and PCE (10 ug/kg) were detected in one sample;

- TCE (32 ug/kg) and PCE (9 ug/kg) were detected in one sample; and

- TCA (13 ug/kg) and PCE (7.8 ug/kg) were detected in one sample.

# 4.0 EFFECTIVENESS OF VAPOR EXTRACTION

Efforts were made to calculate the percentage of VOCs removed from each pile following vapor extraction. This calculation was based on the VOC concentrations in the soils compared to emitted mass from the regenerative blowers. This was intended as a general indication of the effectiveness of the treatment.

Based on the above described calculation, it was estimated that between 83 to 100% of the VOCs were extracted from the three stockpiles. Based on the average, about 90% of all VOCs were removed.

The Ohio EPA policy on "How Clean is Clean?" states that the cumulative risk posed by clean soil should not exceed 1 x $10^6$ excess cancer risk level. Based on the analyses of the three stockpiles, all the regulated components were below this threshold level.

Based on Clean Tech's study of the TPH and fourth stockpiles, it appears these two piles still exceed 105 mg/kg of TPH. The Plant intends to bioremediate these soils and retain them on-site. Clean Tech, therefore, also conducted a biotreatability study to determine if the two stockpiles could be biologically treated.

# 5.0 BIOTREATABILITY STUDY

## 5.1 Background

The purpose of this study was to determine if organisms indigenous to the site and cultured in the lab on specific organic compounds, were capable of degrading the TPH compounds at the Dayton facility. The lab scale study would evaluate the effectiveness of biological treatment of the TPH stockpile and the previously untested fourth stockpile.

On November 6, 1992 composite soil samples were taken from the TPH and the fourth stockpiles by Clean Tech. The first set of six samples was taken from the stockpile designated the TPH stockpile. These samples were composites which were taken at various locations on the side slopes and top of the pile.

The second set of six samples was taken from the pile designated as the fourth pile. A total of six composite samples were taken from the top and at various locations at the side slopes of this pile by Clean Tech.

## 5.2 Results

The soil samples, upon arrival at Clean Tech, were logged in accordance with standard QA/QC procedures. The following parameters were measured for each soil pile sample: pH, nitrate-nitrogen, phosphorous, humus (organic content), ammonia-nitrogen, nitrite nitrogen, and soil moisture. Analysis indicated that nitrogen was lacking in all forms in the soil samples. Analysis also indicated that the soils were lacking in organic matter and were slightly basic.

The feasibility study indicated that the lack of nutrients in the soils was one of the limiting factors for biological treatment at the Dayton site. Microbial respiration, as determined by measuring $CO_2$ evolution, confirmed that the growth of the indigenous microbial community under ambient conditions was occurring but at a very slow rate. This indicated that even though hydrocarbon degrading microbes were present, the present environmental conditions did not allow the existing microbes to function effectively.

Degradation of hydrocarbons by enhanced biological methods is dependent on a number of factors. The most important factors include:

- The existence of indigenous microbes capable of degrading the compounds of concern;
- Hydrocarbon type and concentration;
- Soil type and structure;
- Nutrient availability;
- Moisture content;
- Oxygen availability (Aerobic processes).

The first factor was analyzed for this site. Fertile soils usually contain $10^7$ to $10^9$ microbes per gram of dry soil of which $10^5$ to $10^6$ are hydrocarbon degraders (prior to the addition of hydrocarbons). After hydrocarbons have been added, hydrocarbon degraders typically increase to $10^6$ to $10^8$ microbes per gram of dry soil.

The composite soil sample was analyzed by standard plate count which is a direct quantitative measurement for aerobes and facultative anaerobes. The resultant count was 4 0 x $10^7$ microbes per gram of dry soil This indicated that there is an indigenous microbial population at the site which has been impacted by site conditions. If environmental conditions were suitable, the plate count should have been an order of magnitude greater.

In order to approximate total TPH levels in the soil composite sample, Clean Tech utilized EPA Method 418.1. The initial soil composite contained an approximate TPH level of 113 milligrams per kilogram (mg/kg). At the end of the study, the reactor vessel which contained the appropriate nutrient levels, contained no detectable concentration of TPH This result was compared to the live control which still contained approximately 113 milligrams per kilogram (mg/kg) of TPH. The dead control also had a similar TPH value. This conclusively showed that the bacteria had successfully degraded the contaminants of concern as evidenced by the lack of contaminants in the reactor vessel that contained the necessary nutrients.

The third factor affecting bioremediation is soil type. This affects the ability of the soil to transmit air, water, and nutrients. More permeable soils allow rapid mobility of nutrients The soil analyzed in this study contained some silt and clay which would somewhat restrict permeability

Nutrients and the bioavailability of nutrients is another critical factor Nitrogen and phosphorous were the most critical nutrients lacking in the test soils. The nutrients added in the study were rapidly depleted. Another key factor which had affected nutrient availability is adsorption. Clay soils have a high retention capacity for nutrients. The initial addition of nutrients to the soils may have been tightly bound to the soil thereby allowing only minimal amounts to be available for microbial growth. Subsequent additions of nutrients to the soils showed a rapid uptake of nutrients as measured by increased $CO_2$ production.

Other factors which are important but which were not a limiting factor in this study include temperature and moisture availability. Temperature was kept stable at ambient conditions throughout the study at approximately 20°C. Moisture availability was also adequate. The initial samples had moisture contents above 10%, which is the level at which bioactivity becomes marginal.

The last critical factor in this study is oxygen availability. Oxygen availability controls the rate at which aerobic organisms can function. One liter of air contains 20% oxygen or 256 mg of oxygen. Bioactivity in unsaturated soils is much faster than in saturated soils since an adequate air supply can be provided. All samples were aerated at normal atmosphere concentrations. Enhanced biodegradation will need additional dissolved oxygen.

## 5.3 Conclusions

The study concluded that biological activity was occurring at minimal rates due to restrictive site factors. Nutrient concentrations must be maintained to sustain biological activity due to the retention of nutrients by the soils. The study did confirm that the soils on the site were amenable to bioremediation.

# 6.0 BIOREMEDIATION OF THE TPH & FOURTH STOCKPILES

The biotreatability study established that the regulated compounds could be degraded to below detection limits by microorganisms. Clean Tech proposes to design and operate a land treatment unit to remediate the soil.

The general remediation concept involves moving the soil from the stockpiles and placing the soil in the treatment unit. The treatment unit will consist of 24 inch lifts of soils which will be placed on a liner. The lifts will be interspersed with four-inch PVC piping. The piping will be manifolded back to a biological reactor.

**Biotreatability Study**
**for the**
**Acustar Plant**
**Dayton Thermal Products**
**Dayton, Ohio**

November 1992

**Prepared for:**

Acustar Inc - A Chrysler Company

**Prepared by:**

Clean Tech
Suite 202
225 Corporate Blvd
Newark, DE 19702
(302) 368-7961

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### Figures

## 1.0 INTRODUCTION

**Clean Tech** routinely employs a two (2) level approach to determine the feasibility of enhanced biodegradation in the remediation of contaminated soils and groundwater There are two (2) major criteria which must be met in order to consider biological remediation of the site. The criteria are:

- There must exist within the study site, homogeneous or heterogeneous populations of bacteria capable of using the contaminants of concern as a growth substrate; and

- Alterations of the physical and/or chemical environment must be demonstrated to result in the enhancement of microbial community activity

Failure to meet either of these two criteria indicates that biological approaches to remediation of the site will be difficult to implement In addition, it must also be noted that meeting the above criteria does not necessarily confirm that bioremediation is the best possible treatment option Feasibility studies must be followed by pilot studies in the field and then with field monitoring during the remediation process

The purpose of this study was to determine if organisms indigenous to the site and cultured in the lab on specific organic compounds, are capable of degrading the contaminants of concern

### 1.1 Background

The Acustar Plant is located at 1600 Webster Street in Dayton, Ohio The soil piles from which samples were obtained are delineated in Figure 1

On November 6, 1992 several composite soil samples were taken from the two soil piles contained on-site The first set of six (6) samples were taken from the pile designated the "Total Petroleum Hydrocarbons (TPH) Pile" These samples were composites which were taken at the top of the pile and at various locations on the side slopes of the pile

The second set of six (6) samples were taken from the pile designated as the "Unknown Pile" A total of six (6) composite samples were taken from the top and at various locations at the side slopes of this pile

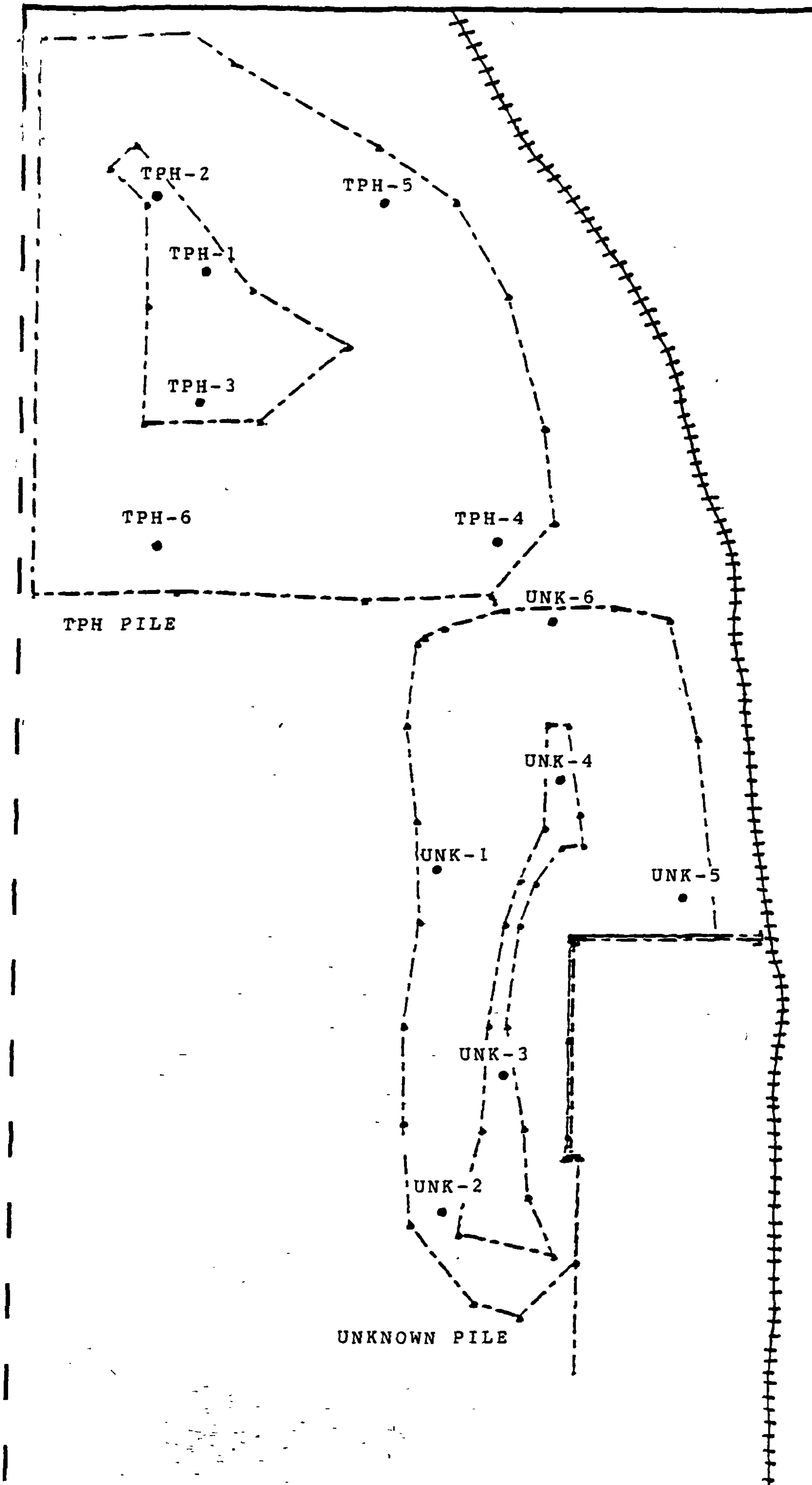



FIGURE 1

Soil Pile Configurations

Acustar, Inc.
Dayton Thermal Products Division
Dayton, Ohio
November 1992

## 1.2 Field Sampling

Composite samples were collected from several locations as discussed in the previous sections from the two soil piles A total of twelve (12) soil samples were taken at the Dayton plant The following is a brief description of each sample location and its characteristics

TPH Pile

**Sample #1** (TPH-1) was taken at the top of the TPH pile This sample was composited between 4 and 5 feet The soil was silt/clay and contained fill material There was no petroleum hydrocarbon odor present.

**Sample #2** (TPH-2) was taken at the top of the TPH pile This sample was composited between 3 and 4 feet The soil was silt/clay and contained fill material

**Sample #3** (TPH-3) was taken at the top of the TPH pile The sample was composited between 4 and 5 feet There was a slight petroleum hydrocarbon odor present The soil from this boring was silt/clay and contained fill material

**Sample #4** (TPH-4) was taken from the side of the TPH pile, adjacent to the railroad tracks This sample was composited between 3 and 4 feet The soil in this boring was a moist silt/clay mixture No petroleum hydrocarbon odor was present

**Sample #5** (TPH-5) was taken from the side of the TPH pile, approximately 300 feet from Sample #4 Initially there was a petroleum hydrocarbon odor present The sample was composited between 4 and 5 feet The soil was a silt/clay mixture

**Sample #6** (TPH-6) was taken from the side of the TPH pile, near the vacuum extraction pumps The sample was composited between 3 and 4 feet There was no petroleum hydrocarbon odor present The soil was a silt/clay mixture

Unknown Pile

**Sample #1** (UNK-1) was taken from the side of the unknown pile, near the storage building The sample was composited between 3 and 4 feet There were no odors present The soil consisted of a silt/fill mixture

**Sample #2** (UNK-2) was taken at the rear of the pile There was a strong petroleum hydrocarbon odor present The soil from this boring consisted of a silt/sand mixture.

**Sample #3** (UNK-3) was taken at the top of the pile, near the waste water treatment plant There was no petroleum hydrocarbon odor present. The soil was silt/sand and contained fill material

**Sample #4** (UNK-4) was taken at the highest point of the pile. The soil was a silt/clay mixture The soil was composited between 3 and 4 feet No petroleum hydrocarbon odor was present

**Sample #5** (UNK-5) was taken from the side of the pile, near the railroad tracks The soil was silt/sand and contained fill material No petroleum hydrocarbon odor was detected The sample was composited between 4 and 5 feet

**Sample #6** (UNK-6) was taken from the front of the pile, across from the TPH pile The sample was composited between 4 and 5 feet The soil was a silt/clay mixture. There was no petroleum hydrocarbon odor present

## 2.0 STUDY PROCEDURES

The soil samples, upon arrival at **Clean Tech**, were logged in accordance with standard QA/QC procedures The following parameters were measured for each soil sample: pH, nitrate-nitrogen, phosphorous, humus (organic content), ammonia-nitrogen, nitrite-nitrogen and soil moisture The samples were then refrigerated at 4°C The results of the soil samples which were analyzed are shown in Table 1

**TABLE 1**
**SOIL CHEMICAL CHARACTERISTICS - INITIAL SAMPLES - ACUSTAR**

| Sample No. | pH | Nitrate | Phosphorous | Ammonia Nitrogen | Nitrite | Organic Content | Moisture % |
|---|---|---|---|---|---|---|---|
| TPH 1 | 8 2 | <5 ppm | 100 ppm | ND | ND | ND | 19 65 |
| TPH 2 | 8 1 | <5 ppm | 75 ppm | ND | ND | ND | 17 87 |
| TPH 3 | 8 2 | <5 ppm | 100 ppm | ND | ND | ND | 20 2 |
| TPH 4 | 8 5 | <5 ppm | 75 ppm | ND | ND | ND | 9 8 |
| TPH 5 | 8.4 | <5 ppm | 100 ppm | ND | ND | ND | 2 11 |
| TPH 6 | 8 1 | <5 ppm | 100 ppm | ND | ND | ND | 7 34 |
| Unknown 1 | 8 3 | <5 ppm | 75 ppm | ND | ND | ND | 7 38 |
| Unknown 2 | 8 2 | 10 ppm | 100 ppm | ND | ND | ND | 6 01 |
| Unknown 3 | 8 6 | <5 ppm | 75 ppm | ND | ND | ND | 8 24 |
| Unknown 4 | 8 3 | <5 ppm | 75 ppm | ND | ND | ND | 9.75 |
| Unknown 5 | 8 4 | <5 ppm | 100 ppm | ND | ND | ND | 8 47 |
| Unknown 6 | 8 2 | <5 ppm | 75 ppm | ND | ND | ND | 6 43 |
| TPH Average* | 8 25 | <5 ppm | 91 67 ppm | ND | ND | ND | 12 8 |
| UNK Average* | 8 3 | <5 ppm | 83 3 ppm | ND | ND | ND | 7 7 |
| Composite* | 8 2 | <5 ppm | 75 ppm | ND | ND | ND | 11 54 |

Note
Average - The arithmetic average of the samples taken from the Dayton Plant
Composite - The chemical characteristics of the sample used for the biotreatability study which was a composite from each of the twelve samples
ND = Not Detected (<1 ppm)

To initiate the study, a total of 1,200 grams were taken from the twelve soil samples to create a composite sample for the treatability study Fifty (50) grams of this composite sample were analyzed for initial TPH content (see Table 2)

**TABLE 2**
**BIOMETER FLASK COMPOSITIONS**

| Sample | TPH (ppm) | MDL |
|---|---|---|
| TPH 1 | ND | 5 ppm |
| TPH 2 | 283 5 | --- |
| TPH 3 | ND | 5 ppm |
| TPH 4 | 170 1 | --- |
| TPH 5 | 113.4 | --- |
| TPH 6 | 56.7 | --- |
| Unknown 1 | 113.4 | --- |
| Unknown 2 | 170 1 | --- |
| Unknown 3 | ND | 5 ppm |
| Unknown 4 | 113 4 | --- |
| Unknown 5 | 170 1 | --- |
| Unknown 6 | 170 1 | --- |
| Average | 113 4 | --- |
| Composite | 113 4 | --- |

Next, approximately fifty (50) grams of the composite sample were placed into each reactor vessel The reactor vessels were allowed to stabilize and become acclimated for a period of two (2) days before their physical and chemical environments were altered This permitted the determination of background respiration rates for each reactor vessel or what is known as the "lag phase" of bacterial growth

Before the amendments were added, respiration rates during the lag phase were measured to ensure that the flasks which were amended were below or equal to the respiration rates measured in the two (2) control flasks A total of five treatment variations were completed for the study The reactor vessels were amended in the following manner.

**TABLE 3**
**BIOMETER FLASK COMPOSITIONS**

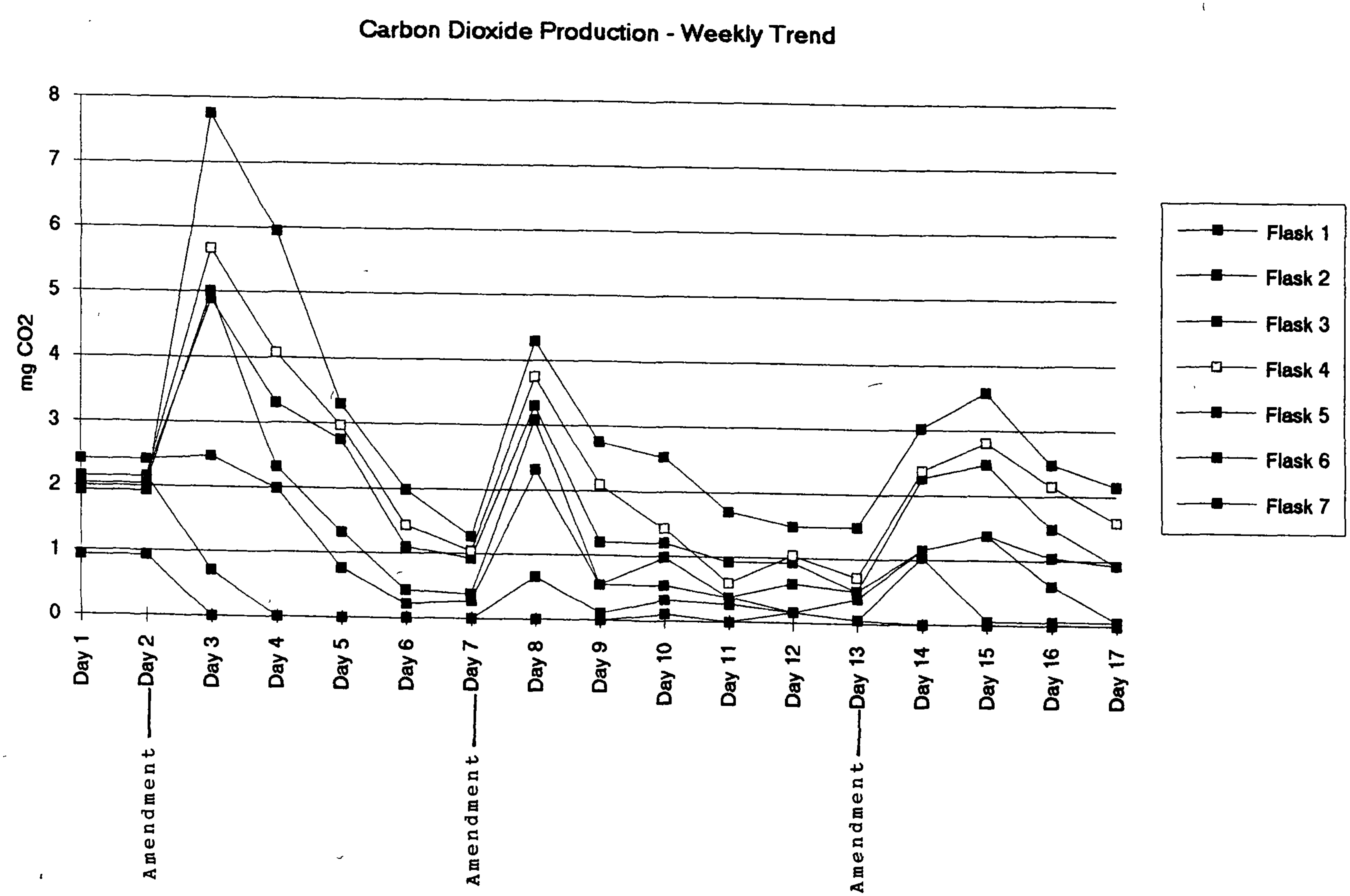
| Reactor Vessel | Nutrient Percentages (Nitrogen:Phosphorous) |
|---|---|
| 1 | 2% |
| 2 | 4% |
| 3 | 5% |
| 4 | 6% |
| 5 | 8% |
| 6 | No amendments (Live Control) |
| 7 | No amendments (Sodium Azide-Killed Control) |

(Note Nutrients. N P = 10 15 ratio)

Reactor vessels 6 and 7 served as controls Vessel 6 contained a composite sample of background soils which were not chemically treated This vessel provided background respiration rates for indigenous bacteria whose environment was not amended Vessel 7 contained a composite soil sample in which the microbes present were destroyed chemically with sodium azide (1% v/w final concentration) All reactor vessels were monitored daily for $CO_2$ production levels

The treatability study was conducted over a seventeen day (24 hour intervals) period Additional nutrients were added in 5 mL aliquots on days seven and thirteen of the study Additional nutritional amendments were added on days seven and thirteen because respiration rates began to decrease at that time In addition, it was believed that the nutrients may have adsorbed onto the soil and were not available for bacterial growth. It was anticipated that adsorption might dominate the response during the first half of the study before nutrients reached equilibrium since the soils were low in nutrients The addition of the second aliquots of nutrients was necessary in order to determine if additional microbial activity could be stimulated with the addition of nutritional supplements (see Figure 2) All other study conditions remained unaltered

Figure 2
Acustar - Dayton, Ohio



## 3.0 GENERAL DISCUSSION

Bench scale studies are conducted to gather baseline information on such process limiting factors as· oxygen, moisture requirements, and the need for nutritional supplements In this section we will further discuss these factors

### 3.1 Nutrient Requirements

Microorganisms require the nutrients nitrogen and phosphorous to grow as well as other micronutrients However, these materials are either available in insufficient quantities or are completely lacking in the environment. Therefore, it often becomes necessary to add supplemental nitrogen and phosphorous to the environment to enhance biodegradation

The key to accelerating the natural degradation process is to maintain a sufficiently high threshold concentration level of the nutrients nitrogen and phosphorous Sufficient amounts of nitrogen and phosphorous must be available to balance the available carbon The available carbon for this site is the hydrocarbon contaminant The threshold concentration level is a function of several factors Two of the most significant factors are the degree of microbial utilization, and the amount of adsorption of the nutrients onto the soil

The ideal metabolic ratio of Carbon to Nitrogen is 10 1 and Carbon to Phosphorous, 20 1 For the majority of hydrocarbons, it can be assumed that all of the contaminant becomes a carbon source for the microbes One can then estimate the amount of nitrogen and phosphorous required for remediation However, soil retention of nutrients is a key factor which must also be assessed Retention of nutrients can be quite high, ranging from 10's to 100's of ppm It is this retention factor that is often the deciding factor of the nutritional needs of the microbes which are necessary for bioremediation.

At the Acustar site, nitrogen was lacking in most of the soil samples The tests also indicated that there was minimal humus or organic matter present Organic content aids in supplying nutrients (nitrogen and phosphorous) and increases the nutrient retention capacity of the soil This lack of organic matter may explain why there was a minimal amount of nitrogen in the initial samples (see Table 1)

## 3.2 $O_2$ Requirements

In general, the aerobic biodegradation process is a more efficient and rapid metabolic pathway than the anaerobic process With oxygen, however, the supply/demand situation is quite different from that of nutrients Considerably more oxygen than nitrogen or phosphorous is required for biodegradation since each kilogram of hydrocarbon that is metabolized requires approximately 3 4 kilograms of oxygen to convert it to carbon dioxide and water

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Reaction | $(CH_2)$ | + | $1\ 5\ O_2$ | $\rightarrow$ | $CO_2$ | + | $H_2O$ |
| Weights: | 14 kg | | 48 kg | | 55 kg | | 18 kg |

In unsaturated or shallow soils, the oxygen supply can be severely limited within inches of the surface. This problem is readily corrected by tilling the soil Tilling the soil provides the oxygen essential for enhanced bioremediation

In saturated or deep soils, supplying oxygen to the microorganisms is far more difficult An effective way of supplying oxygen to a saturated or deep system is to use a chemical source, such as hydrogen peroxide

An advantage to using hydrogen peroxide as an oxygen source is that it readily dissolves in water However, hydrogen peroxide is also a biocide Thus, it must be added at levels that are not toxic to microbes but which are still capable of maintaining a high oxygen content

At the Acustar Plant, a significant percentage of the soil piles were fill, consisting of clay and silt This fill has been compacted, thus allowing little oxygen to diffuse beneath the surface of the soil Biological activity has been severely limited because of this and the treatment system will need to be designed to increase oxygen to the soils

## 3.3 Moisture

Moisture is very important to the success of in-situ bioremediation In general, there are two (2) extremes which must be avoided Soil moisture conditions should be maintained between 15 and 25% and pooling and/or flooding of water should be avoided (standing water causes denitrification) Extremely dry conditions (less than 10%) should also be avoided

The soils taken from the site have soil moistures between 2 11% and 20 2% These conditions must be accommodated in the design.

**3.4 Soil pH**

Soil pH should be kept in the neutral to alkaline range The aerobic breakdown of organic molecules sometimes results in the accumulation of organic acid intermediates which reduces the pH and may subsequently inhibit biological activity This effect can easily be corrected through the addition of chemicals to adjust the pH to be more alkaline with additives such as lime.

The soils found at Dayton are slightly alkaline However, the bacterial reduction of contaminants will reduce the pH All reactor vessels were adjusted to a neutral pH of 7 for the duration of the study

**3.5 Nitrogen**

Reduction of contaminants may occur with the use of nitrate ($NO_3$) as a terminal electron acceptor (denitrification). This involves the reduction of $NO_3$ to $N_2$ This reduction occurs in the following sequence $NO_3^- \rightarrow NO_2^- \rightarrow N_2$ During aerobic denitrification, $NO_3$ serves as the terminal electron acceptor so that oxygen is available for reduction of the organic contaminant

The enzymes necessary to complete denitrification are only formed under anaerobic conditions or conditions of low oxygen tension In most cases nitrate is required as the inducer Also, the activity of the enzymes involved in nitrate reduction to $N_2$ are strongly inhibited by $O_2$ Thus, denitrification can only take place when $O_2$ is absent or only available in insignificant quantities

If denitrification is to occur, there must be significant quantities of nitrogen available for the bacteria to grow It becomes extremely important to develop a high organic content in the soil Unlike most nutrients, nitrate migrates with percolating water, making it difficult to provide adequate storage quantities in the soil Nitrogen, however, is fixed in the soil in a stable form Denitrification is not the preferred biological activity at the Acustar site

# 4.0 STUDY DISCUSSION

## 4.1 Soil Chemical Characteristics

The study results were reviewed to determine if the two criteria were met in order for bioremediation to be effective at the site. The first criteria was to determine if there was an indigenous population of bacteria capable of using the contaminants of concern as a growth substitute The second criteria that must be met is that the changes to the environment must result in an increase in microbial growth as measured by carbon dioxide production levels.

The soils were analyzed for pH, nitrogen content, organic matter, moisture and phosphorous. The chemical characteristics of the samples before physical/chemical alterations are contained in Table 1 The results indicate that nitrogen was lacking in all forms in the soil samples One possible explanation for the lack of nitrogen is that the soils were depleted of nutrients due to microbial activity which is occurring at the site although at minimal levels. Over time this activity results in the depletion of nutrients in the soil

The soils were also found lacking in organic matter The organic content of soils is important for bioremediation to be effective for several reasons. Organic matter aids in moisture retention, it supplies various nutrients and it increases the nutrient retention capacity of the soil The lack of organic matter in these soils may partially explain the lack of nutrients in the soil samples Organic matter also enhances soil aeration, making the soils aerobic instead of anaerobic. An average soil contains 3-5% organic matter All the samples analyzed contained no detectable amounts of organic matter.

The soils in the initial composite were also slightly basic As the microbes degrade contaminants of concern, the pH of the soils is reduced At the conclusion of this treatability study, through nutrient addition, nitrate, nitrite, phosphorous, and ammonia levels had increased slightly and pH had been chemically adjusted as shown in Table 4

## TABLE 4 - SOIL CHEMICAL CHARACTERISTICS FINAL SAMPLES

| | Soil pH | Nitrate | Phosphorous | Ammonia Nitrogen | Nitrite |
|---|---|---|---|---|---|
| Reactor Vessel 1 | 7 8 | 50 ppm | 100 ppm | 10 | ND |
| Reactor Vessel 2 | 7 6 | 50 ppm | 100 ppm | 10 | ND |
| Reactor Vessel 3 | 7 3 | 30 ppm | 50 ppm | 40 | ND |
| Reactor Vessel 4 | 7 6 | 20 ppm | 37 5ppm | 100 | ND |
| Reactor Vessel 5 | 7 4 | ND | 12 5 ppm | 100 | ND |
| Reactor Vessel 6 | 7 9 | <5 ppm | 75 ppm | ND | ND |
| Reactor Vessel 7 | 7 9 | <5 ppm | 75 ppm | ND | ND |

ND = Not Detected (<1ppm)

### 4.2 Treatability Study

A review of the study on a daily basis is necessary in order to understand what factors may be limiting bioremediation

On day one, the samples were allowed to stabilize after a composite soil sample had been made from the twelve discrete samples An aliquot of the composite sample was then analyzed for soil chemical characteristics This composite sample initially contained negligible amounts of nitrate and no ammonia or nitrite as previously discussed The composite sample also contained approximately 75 ppm of phosphorous The organic content of the composite sample was less than 1% and the sample had a moisture content of 11 54%

On day two of the study, the nutrients were added to the reactor vessels as discussed $CO_2$ production levels were measured for each reactor vessel The two control vessels showed minimal $CO_2$ production, as expected Reactor vessels 1 through 5, showed similar rates of $CO_2$ production. The live control (Reactor Vessel 7) did not receive any amendments, therefore it provided the baseline or background production rate for carbon dioxide levels

On day three, 24 hours after the initial addition of nutrients, the $CO_2$ level began to increase This increase in $CO_2$ level was due to the addition of nutrients and aeration by mixing the soils in the reactor vessels All vessels including the controls were agitated on a mechanical mixer for ten minutes Reactor vessels 1 through 5 showed production levels greater than both the live control (Reactor Vessel 6) and the dead control (Reactor Vessel 7), as expected

On day four, the carbon dioxide levels were again measured in each reactor vessel $CO_2$ production levels had slightly decreased from the previous day This was expected since the samples were not mixed or aerated as they had been on day three The $CO_2$ production levels showed that reactor vessels 4 and 5 which contained the highest nutrient levels, yielded the highest $CO_2$ concentrations. All reactor vessels showed $CO_2$ production levels greater than the live control, which indicates that biological activity is occurring in all flasks because of physical and chemical amendments to the soils The killed control showed no discernible $CO_2$ production rate.

On days five, six, and seven, $CO_2$ production levels continued to fall Reactor vessels 1 through 5 did register $CO_2$ levels greater than the live control, which indicates that metabolic activity was occurring, although at lower levels than before After the $CO_2$ readings were taken on day seven, additional nutrients were added to the reactor vessels to determine if there would be a concomitant increase in metabolic activity Additional nutrients were also added since it was believed that there may have been some adsorption of the soils of the initial nutrients To overcome the adsorption effect, additional nutrients would be necessary

On day eight, there was an increase in metabolic activity, as evidenced by increased $CO_2$ rates The live control also showed slightly elevated $CO_2$ levels because of the aeration and mixing, as expected

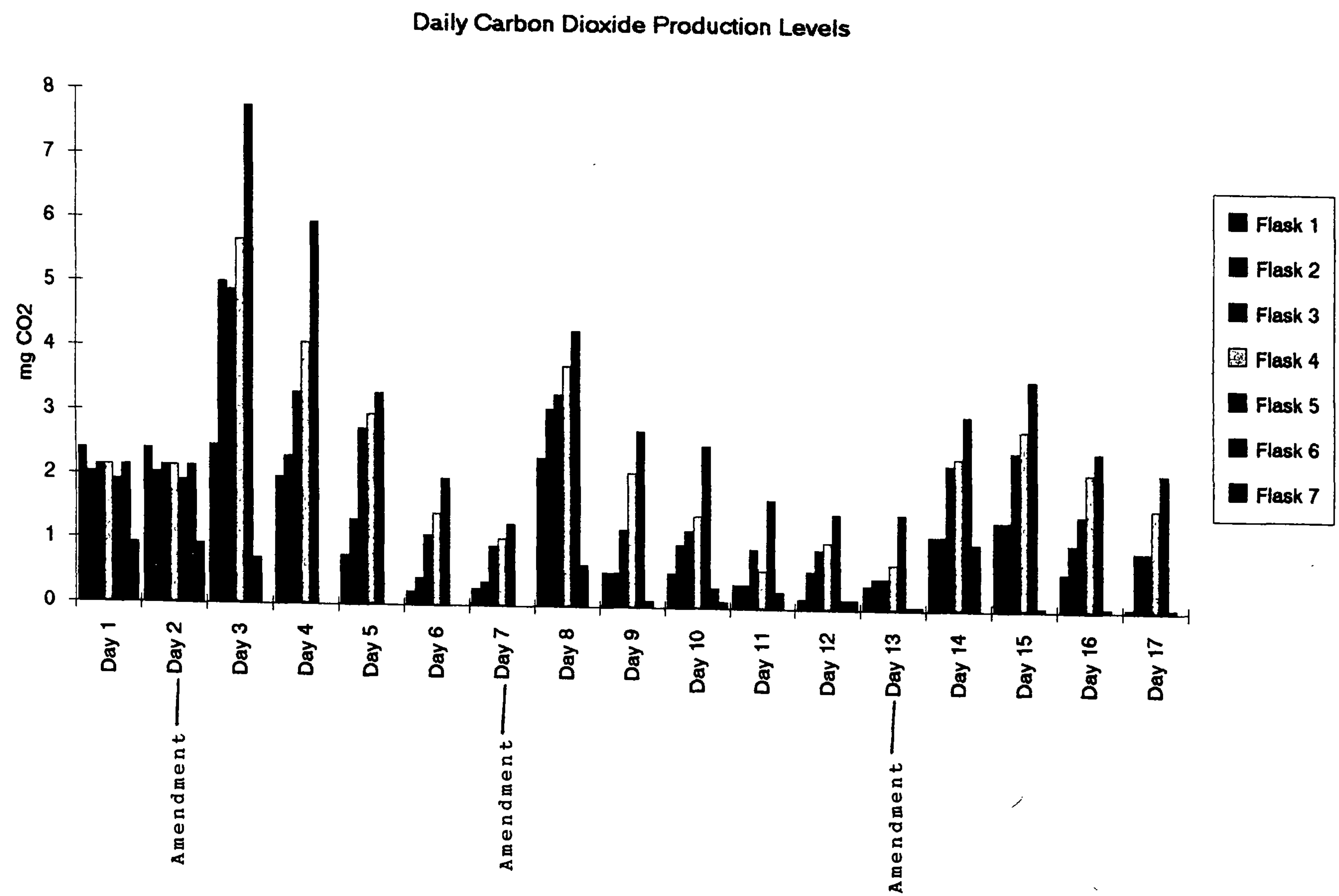
On day nine the $CO_2$ production levels again began to decrease Reactor vessels 4 and 5, which contained the highest concentrations of nutrients, yielded the greatest $CO_2$ production All reactor vessels again showed $CO_2$ production levels higher than that of the live control The dead control performed as expected with no $CO_2$ production

On days ten, eleven, twelve, and thirteen $CO_2$ production levels continued to fall. Reactor vessels 1 through 5 did register $CO_2$ levels greater than the live control, which indicates that metabolic activity was occurring, although at lower levels than before After the $CO_2$ readings were taken on day thirteen, additional nutrients were added to the reactor vessels to determine if there would be a simultaneous increase in metabolic activity

On days fourteen and fifteen there was an increase in metabolic activity, however, the response was not as dramatic as earlier amendments This is due in part to the build up of metabolic wastes in the small, controlled environment within the reactor vessel.

On days sixteen and seventeen, the $CO_2$ production levels began to decrease. Reactor vessels 1 through 5 did register $CO_2$ levels greater than the live control which indicated that metabolic activity was occurring, although at lower levels than before Reactor vessel 5, which contained 8% nutrients, achieved the highest sustained $CO_2$ production levels, indicating that lack of nutrients is a major factor presently inhibiting biodegradation (see Figure 3) Table 4 shows the final results of the chemical characteristics of the soil for each reactor vessel. The final chemical results indicate that the bacteria were nitrogen starved in all forms The pH had been adjusted to optimal levels for maximum bacterial growth.

Figure 3
Acustar - Dayton, Ohio



# 5.0 COLD STUDY

## 5.1 Introduction

In addition to the soil biotreatability study of the soils at ambient temperature at the Acustar Plant, **Clean Tech** also performed a biotreatability study on the soil at 4°C.

## 5.2 Study Background

The study was conducted using three (3) biometer vessels labeled A, B and C Reactor vessel A was amended on the second day with an 8% mixture of nutrients (N P = 10 15) Reactor vessel B was not amended and served as a live control This vessel provided background respiration rates for indigenous microbes whose environment were not amended. Reactor vessel C contained a composite sample in which the microbes present were destroyed chemically with sodium azide (1% v/w final concentration) All three reactor vessels were monitored for daily $CO_2$ production levels

**TABLE 5 - BIOMETER FLASK COMPOSITIONS**

| Reactor Vessel | Nutrient Percentages (Nitrogen:Phosphorous) |
|---|---|
| A | 8% |
| B | No amendments (Live control) |
| C | No amendments (Sodium Azide-killed control) |

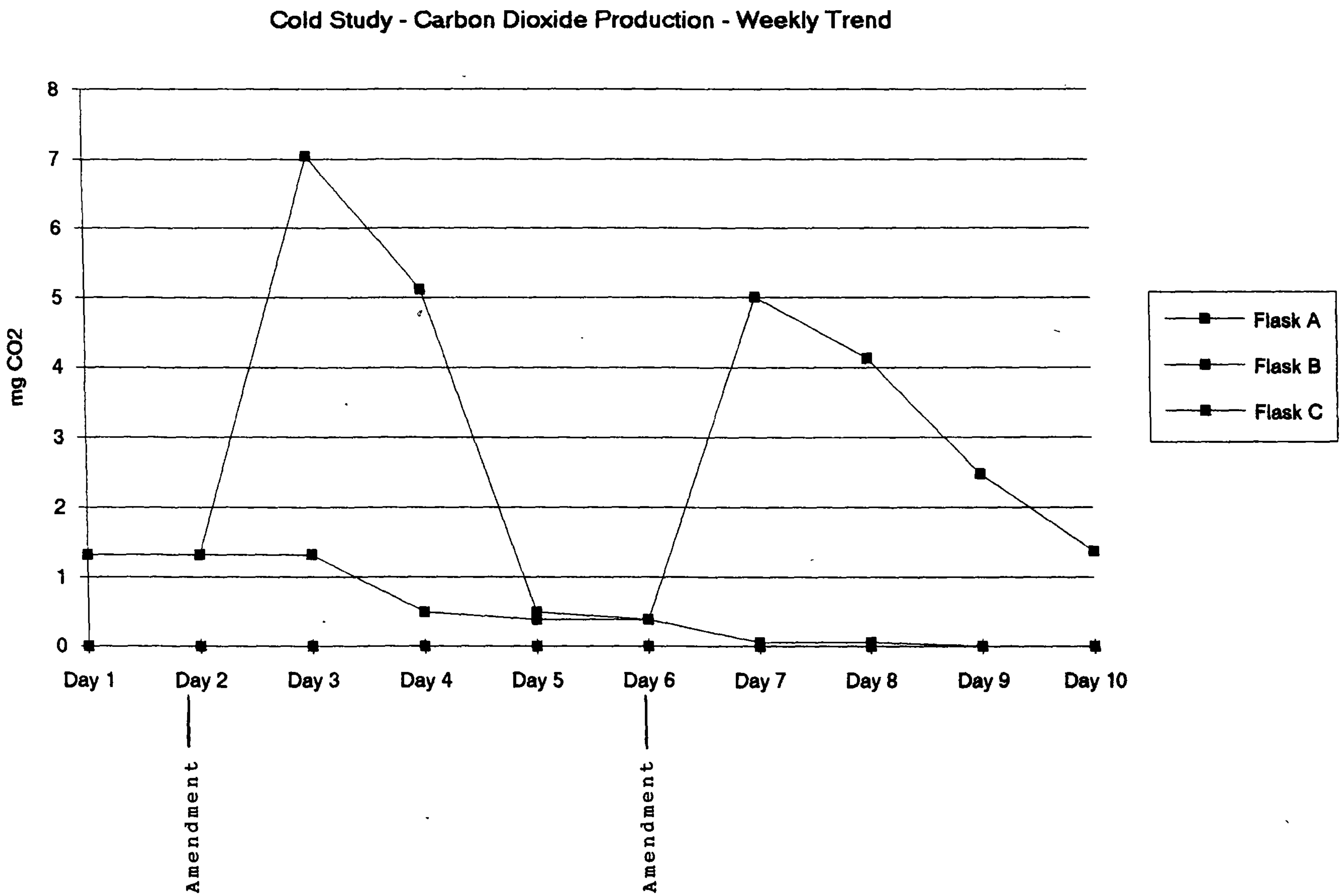
(Nutrients N P = 10 15 ratio)

This portion of the treatability study was conducted over a ten day (24 hour intervals) period Nutrients were added in 5 mL aliquots on day 2 It was anticipated that adsorption might dominate the response during the first days of the study before the nutrients reached equilibrium All other study conditions remained unaltered (see Figure 4)

## 5.3 Study Overview

A review of the study on a daily basis is necessary to understand what factors may be limiting bioremediation

Figure 4
Acustar - Dayton, Ohio



On day one, the samples were allowed to stabilize after a composite soil sample had been made from the twelve discrete samples An aliquot of the composite sample was then analyzed for soil chemical characteristics This composite sample initially contained no nitrate-nitrogen and no ammonia or nitrite as previously discussed. The composite sample also contained approximately 75 ppm of phosphorous The organic content of the composite sample was approximately 1% with a moisture content of 11.54%. The flasks were incubated at 4°C

On day two of the study, the nutrients were added to the reactor vessels as discussed. $CO_2$ production levels were measured for each reactor vessel The two control vessels showed minimal $CO_2$ production, as expected. Reactor vessel A showed the greatest increase in the rate of $CO_2$ production The live control (Reactor Vessel B) did not receive any amendments, therefore it provided the baseline or background production rate for carbon dioxide levels The flasks were incubated at 4°C

On day three, 24 hours after the initial addition of nutrients, the $CO_2$ level began to increase in reactor vessel A This increase in $CO_2$ level was due to the addition of nutrients and aeration by mixing the soils in the reactor vessels All vessels including the controls were agitated on a mechanical mixer for ten minutes Reactor vessel A showed a production level greater than both the live control (Reactor Vessel B) and the dead control (Reactor Vessel C) The flasks were again incubated at 4°C

On day four, the carbon dioxide levels were again measured in each reactor vessel $CO_2$ production levels had slightly decreased from the previous day This was expected since the samples were not mixed or aerated as they had been on day three The $CO_2$ production levels showed that reactor vessel A which contained the additional nutrients, yielded the highest $CO_2$ concentration Reactor vessel A showed a $CO_2$ production level greater than the live control, which indicates that biological activity is occurring in the flask because of physical and chemical amendments to the soils The killed control showed no discernible $CO_2$ production rate The flasks were again incubated at 4°C

On days five and six, $CO_2$ production levels continued to fall Reactor vessel A did register a $CO_2$ level greater than the live control, which indicates that metabolic activity was occurring, although at a lower level than before After the $CO_2$ readings were taken on day seven, additional nutrients were added to the reactor vessels to determine if there would be a simultaneous increase in metabolic activity It was also believed that there may have been some adsorption on the soils of the initial nutrients and to overcome this, additional nutrients would be necessary

On day seven, there was an increase in metabolic activity, as evidenced by increased $CO_2$ rates. The controls also showed slightly elevated $CO_2$ levels because of the aeration and mixing, as expected.

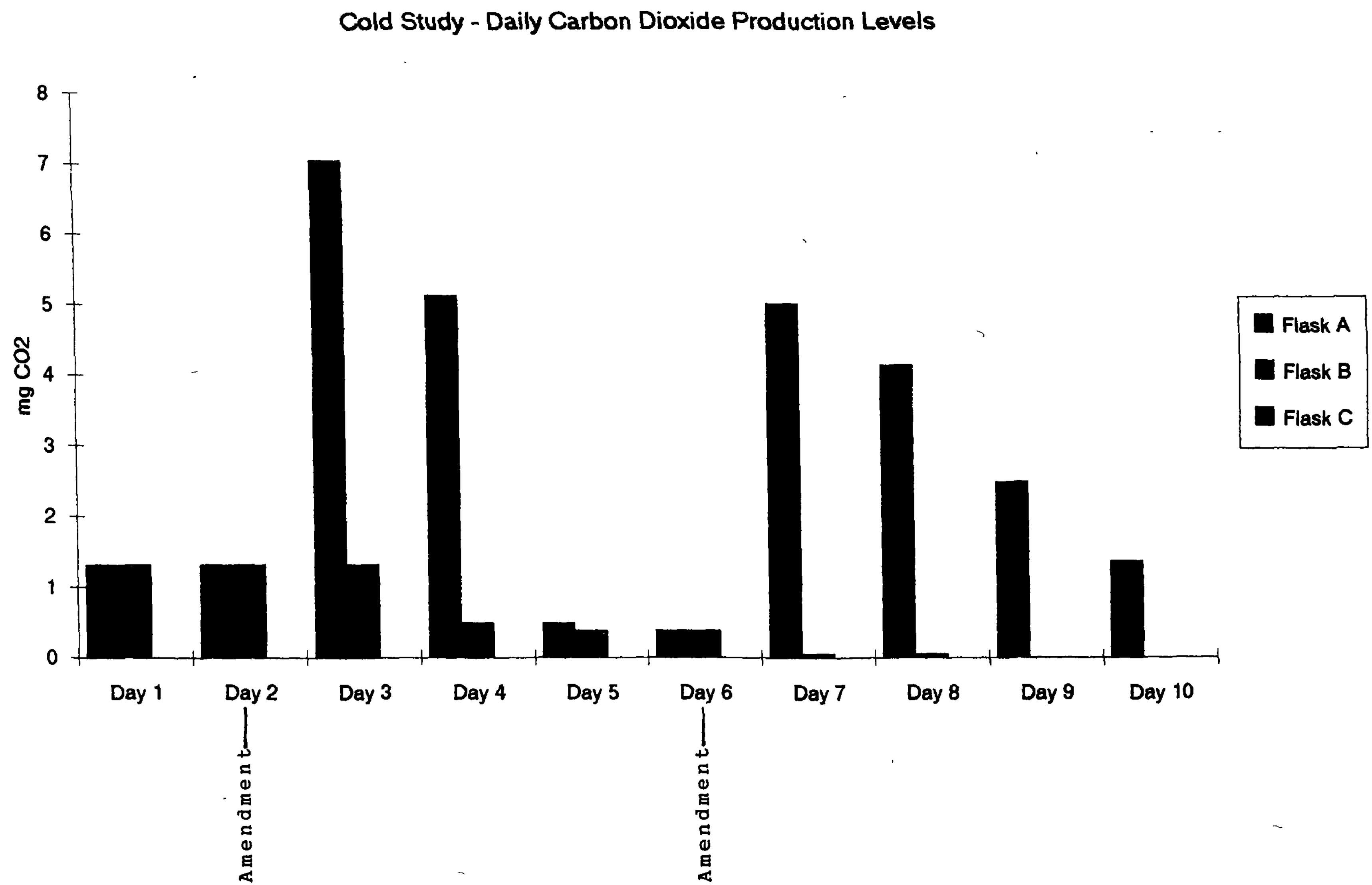
On day eight, nine, and ten, the $CO_2$ production levels began to decrease. Reactor vessel A did register a $CO_2$ level greater than the live control, which indicated that metabolic activity was occurring, although at a lower level than before Reactor vessel A, which contained 8% nutrients, achieved the highest sustained $CO_2$ production levels, indicating that lack of nutrients is a major factor presently inhibiting biodegradation (see Figure 5). Table 6 shows the final results of the chemical characteristics of the soil for each reactor vessel. The final chemical results indicate that the bacteria were nitrogen starved in all forms. The pH had been adjusted to optimal levels for maximum bacterial growth

**TABLE 6 - SOIL CHEMICAL CHARACTERISTICS - FINAL SAMPLES**

| Reactor Vessel | pH | Nitrate | Phosphorous | Ammonia Nitrogen | Nitrite |
|---|---|---|---|---|---|
| A | 7 6 | ND | 12 5 ppm | 100 ppm | ND |
| B | 7 2 | <5 ppm | 75 ppm | ND | ND |
| C | 7 1 | <5 ppm | 75 ppm | ND | ND |

ND = Not Detected (<1 ppm)

Figure 5
Acustar - Dayton, Ohio



## 6.0 CONCLUSIONS AND RECOMMENDATIONS

The feasibility study indicated that the lack of nutrients in the soils is one of the limiting factors at the Dayton site. Microbial respiration, as determined by measuring $CO_2$ evolution, confirmed that the growth of the indigenous microbial community under ambient conditions was occurring but at a very slow rate This indicates that even though hydrocarbon degrading microbes are present, the present environmental conditions do not allow the existing microbes to function effectively.

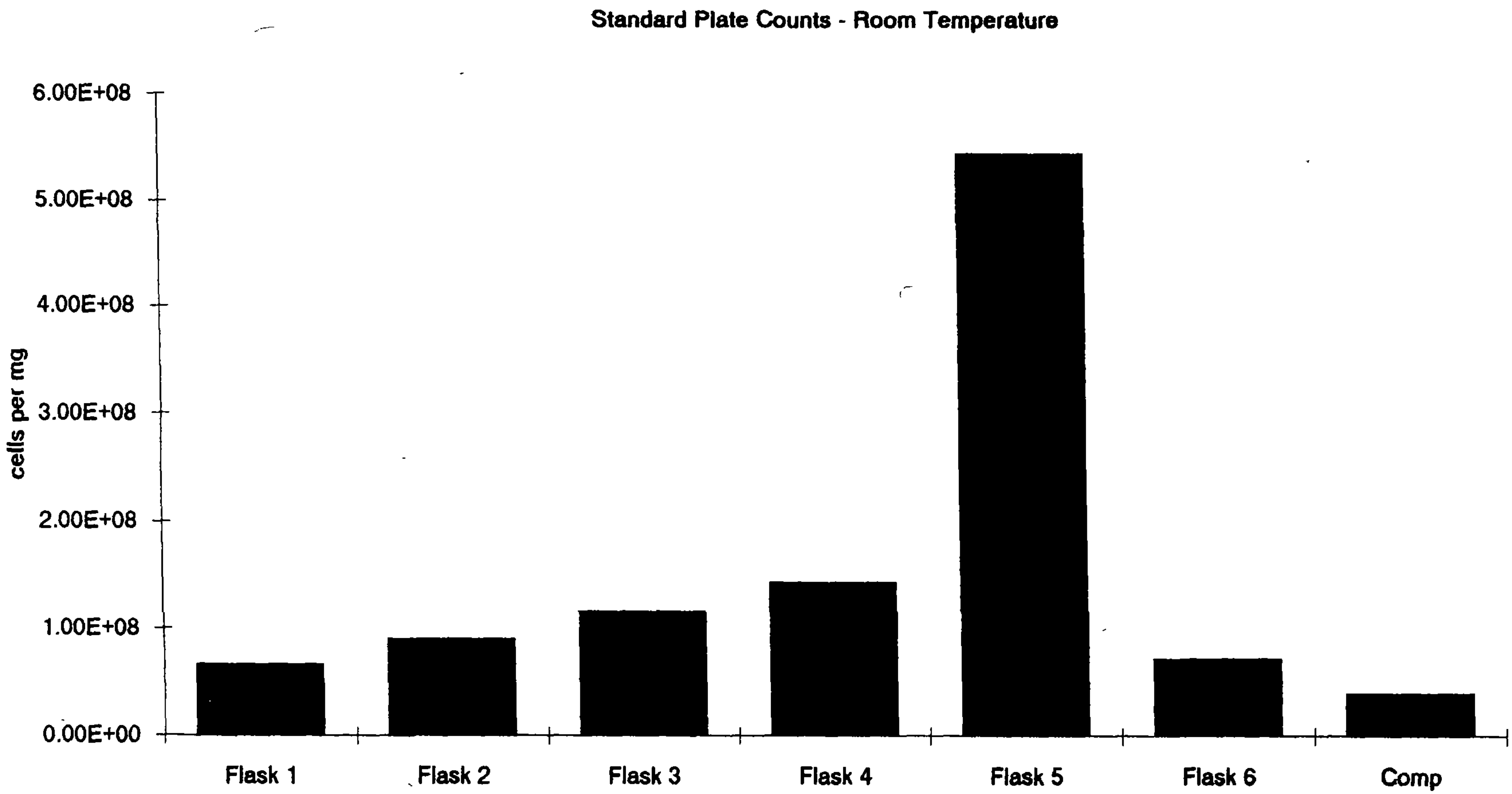
Degradation of hydrocarbons by enhanced biological methods is dependent on a number of factors. The most important factors include

- The existence of indigenous microbes capable of degrading the contaminants of concern,
- Hydrocarbon type and concentration,
- Soil type and structure,
- Nutrient availability,
- Moisture content,
- Oxygen availability (Aerobic processes)

The first factor was analyzed for this site. Fertile soils usually contain $10^7$ to $10^9$ microbes per gram of dry soil of which $10^5$ to $10^6$ are hydrocarbon degraders (prior to the addition of hydrocarbons) After hydrocarbons have been added, hydrocarbon degraders increase to $10^6$ to $10^8$ microbes per gram of dry soil

The composite soil sample was analyzed by standard plate count which is a direct quantitative measurement for aerobic and facultative anaerobes The standard plate count for the Dayton soil composite was $4\ 0 \times 10^7$ microbes per gram of dry soil (see Figure 6) These indicate that there is an indigenous microbial population at the site which have been impacted by site conditions If environmental conditions were suitable, the plate count should have been an order of magnitude greater The microbial population count will have to be significantly increased to achieve desired contaminant reduction levels

Figure 6
Acustar - Dayton, Ohio



The type of hydrocarbon and its concentration also have a significant impact on biological activity Hydrocarbons with less than 10 carbon atoms are relatively easy to degrade as long as the concentrations are not toxic to the bacteria As molecular size increases, the rate will decrease at an almost disproportionate rate Gasoline contains five to fourteen carbon atoms. Kerosene contains nine to eighteen carbon atoms. Light oils contain fourteen to eighteen carbon atoms and heavy oils contain nineteen to twenty five carbon atoms. The soils in this study were apparently contaminated with a variety of oils which contain approximately five to fourteen carbon atoms This may slow the rate of bioactivity.

In order to approximate total TPH levels in the soil composite sample, **Clean Tech** utilized EPA Method 9071. The initial soil composite contained an approximate TPH level of 113 ppm At the end of the study, Reactor Vessel 5 (8% nutrients) contained no detectable concentration of TPH The live control (Reactor Vessel 6) had an approximate end TPH value of 113 ppm The dead control (Reactor Vessel 7) had an approximate end TPH value of 113 ppm The above data indicates that the bacteria had successfully degraded the contaminants of concern as evidenced by the lack of contaminants in vessel 5

In order to determine the TPH levels in the Cold study, the same EPA Method 9071 was used Again the initial soil composite contained 113 ppm of TPH At the end of the study, Reactor Vessel A (8% nutrients) contained no detectable concentrations of TPH. The live control (Reactor Vessel B) had an end TPH value of 110 ppm The dead control (Reactor Vessel C) had an end TPH value of 110 ppm The above data, while only an approximation does show a consistent trend

The third factor affecting bioremediation is soil type This affects the ability of the soil to transmit air, water and nutrients More permeable soils allow rapid mobility of nutrients The soils analyzed in this study contained some silt and clay which may somewhat restrict permeability If the soils are excavated and amended with an organic source this will increase permeability The excavation and tilling process will also allow enhanced aeration to occur which will further increase the transfer of nutrients to the soils Soil pH will also have to be adjusted If the soils are not excavated, a drainage system must be installed properly to allow rapid infiltration.

Nutrients and the bioavailability of nutrients is another critical factor Nitrogen and phosphorous are the most critical nutrients lacking in the test soils, although it is almost certain that other micronutrients are also deficient. The nutrients added in the study were rapidly depleted Another key factor which had affected nutrient availability is adsorption Clay soils have a high retention capacity for nutrients The initial addition of nutrients to the soils may have been tightly bound to the soil thereby allowing only minimal amounts to be available for microbial growth. Therefore, using standard stoichiometric equations will not provide feed rate solutions Assumptions must be made on the adsorptive capacity of the soils

Other factors which are important but which were not a restrictive factor in this study include temperature and moisture availability Temperature was kept stable at ambient conditions throughout the first part of the study at approximately 20°C However, during the second part of the study (Cold study) the temperature was kept stable at 4°C Even though both studies showed an increase in microbial activity, the ambient study indicated greater respiration rates and biomass production (See Figures 7 and 8) Moisture availability was also adequate The majority of the initial samples were above 10%, which is the level at which bioactivity becomes marginal

The last critical factor in this study is oxygen availability Oxygen availability controls the rate at which aerobic organisms can function One liter of air contains 20% oxygen or 256 mg of oxygen Bioactivity in unsaturated soils, is much faster than in saturated soils since an adequate air supply can be provided All samples were aerated at normal atmosphere concentrations Enhanced biodegradation will need additional dissolved oxygen

Figure 7
Acustar - Dayton, Ohio

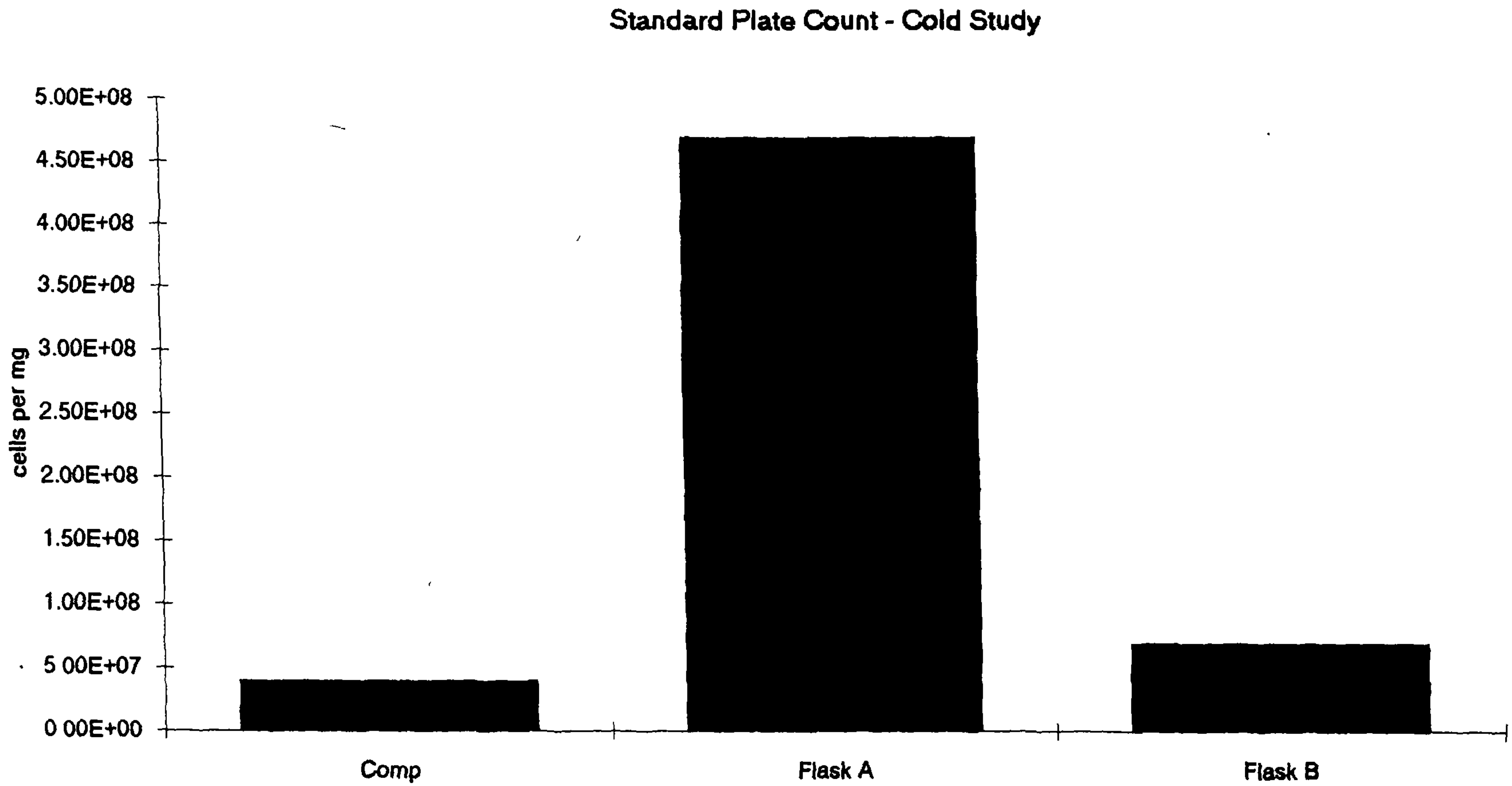
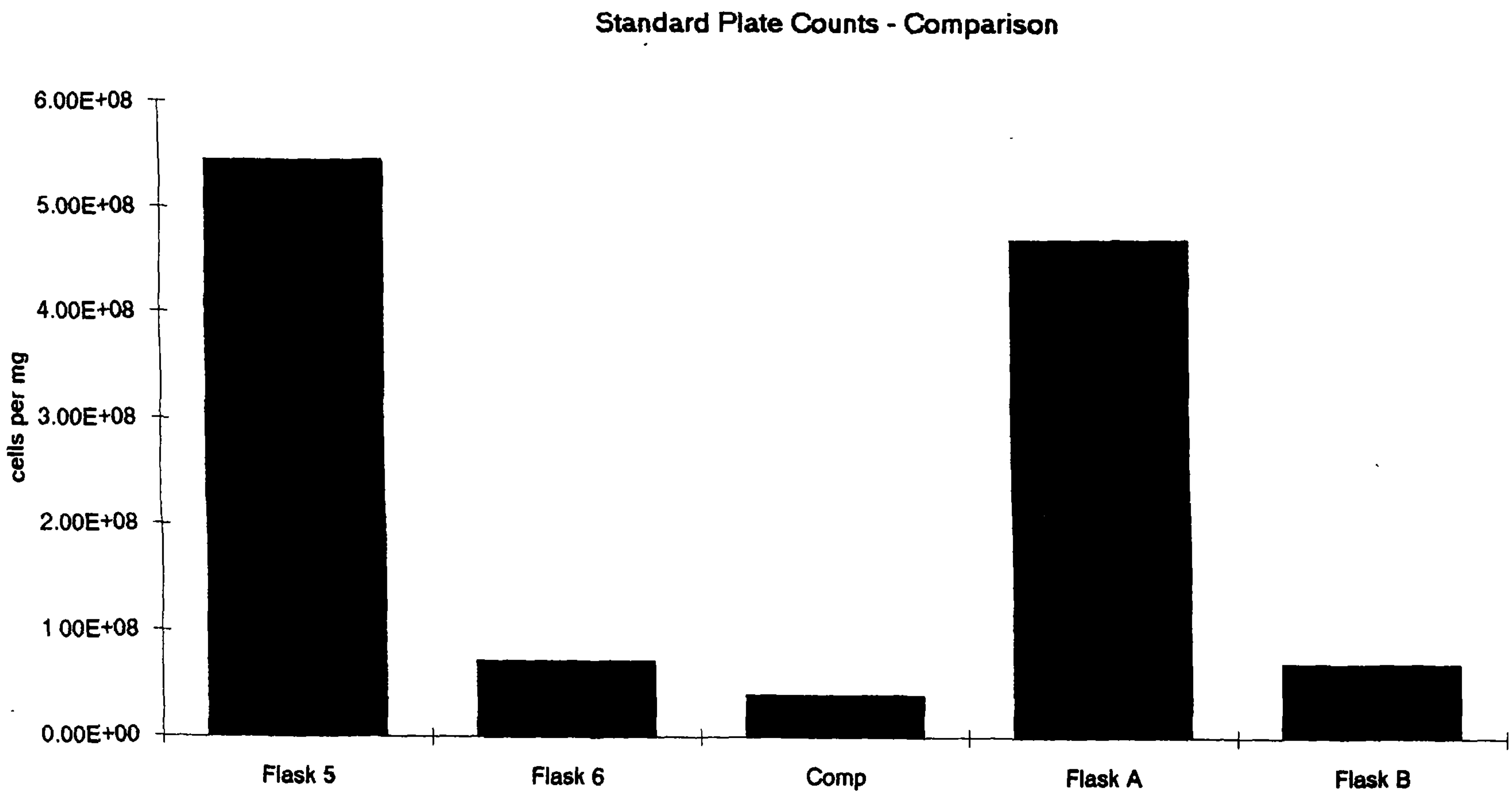


Figure 8
Acustar - Dayton, Ohio



In summary, the following recommendations are made

1. The study indicates that biological activity is occurring at the site although at low levels. The contaminants of concern can be degraded, as evidenced by this study The study indicated that there are several environmental factors at the site severely restricting biodegradation

2. Enhanced biodegradation will degrade the contaminants of concern however site conditions must be significantly altered. In order to increase the rate of biodegradation, microbial growth rates must be increased. This will be accomplished by adjusting the environmental factors which are restrictive. These include

   <u>pH</u> - The pH of the soil is near neutral to alkaline Once metabolic activity begins, the soils will become more acidic Additives must be used to adjust the pH to neutral levels

   <u>Organic Matter</u> - The soils have apparently been depleted of organic matter The soils should be amended with a peat or other organic rich substance This will not only increase the nutrients in the soil but will also assist with aeration, moisture and nutrient retention

   <u>Nutrients</u> - The study confirmed that all essential nutrients were lacking at the site The soils should be amended with nitrogen and phosphorous as discussed in previous sections

   <u>Oxygen Availability</u> - Oxygen levels must be increased in the soils to increase bioremediation

3) The feasibility study conducted on the soils indicated that microbial respiration, as determined by carbon dioxide evolution measurements, was occurring The study indicated that the growth of the indigenous community under ambient conditions was occurring but at a very slow rate Even though hydrocarbon degrading microbes are present, the present environmental conditions do not allow the existing microbes to function effectively

4) A pilot study should be completed in the field with the soils amended as described in this report The soils should be placed on a liner system which will capture run-on and run-off The site should be monitored for all the key factors such as, pH, temperature, bacterial enumeration, nutrient levels, and contaminant levels. It would also be helpful to include in-place lysimeters which would measure $CO_2$ production levels in the field The study should closely simulate the conditions which would exist for land-farming

The study did conclude that biological activity was occurring at minimal rates due to restrictive site factors. Nutrient concentrations must be maintained to sustain biological activity due to the retention of nutrients by the soils. Oxygen availability is another major factor. The soils must be treated in a manner such that the microbes do not experience anaerobic conditions The study did confirm that the soils on the site were amendable to bioremediation

A combination of site factors and the type and concentrations of contaminants have affected biodegradation A pilot test should be designed to mitigate these limiting factors

CLEAN**TECH**

Clean Tech, Inc
Environmental Consultants

2700 Capitol Trail
Newark, DE 19711
302•999•0924
FAX 302•999•0925

# SOLID PHASE BIOREMEDIATION TECHNOLOGIES OF PETROLEUM CONTAMINATED SOILS

**Prepared by:**

**Clean Tech, Inc.**
**2700 Capitol Trail**
**Newark, DE 19711**

**November 17, 1995**

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# APPLICATION OF SOLID PHASE BIOREMEDIATION TECHNOLOGIES OF PETROLEUM CONTAMINATED SOILS


## ABSTRACT

Bioremediation technologies use microorganisms (both bacteria and fungi) to degrade contaminants such as petroleum hydrocarbons, chlorinated solvents and halogenated aromatic hydrocarbons. Bioremediation technologies can be used to effectively remediate contaminated water, air and soils through effectively mitigating rate limiting factors to optimize the process. This report will detail the process of treating soils biologically to decontaminate soil impacted by fuel oils and hydraulic lubricating oils at the Chrysler Facility in Dayton, Ohio.

This technology was applied to remediate contaminated soils that were stockpiled into two separate piles. Investigations during construction and demolition activities indicated that the soils had been impacted by fuel oils and hydraulic oils

The soils were analyzed for Total Petroleum Hydrocarbons (TPH). Previous analytical reports were obtained for volatiles. Concentrations ranged from approximately 300 mg/kg in the most contaminated areas to non-detect in the least contaminated areas. Regulatory imposed cleanup criteria was 105 mg/kg for TPH. Prior to moving the soils to a treatment cell, a treatability study was completed. The study provided critical information on environmental limiting factors such as, oxygen requirements, nutrients and cofactors, and bacterial population data.

After the treatability study determined that the soils were amenable to bioremediation, the individual soil piles were moved and combined into one, lined treatment cell. The

treatment cell was lined with a PVC liner. A bioreactor was mobilized on-site to supply nutrients, bacteria and other supplements to the soils to enhance the biodegradation process. Run-off from the treatment cell was captured in a sump and pumped into the bioreactor where the water was amended with nutrients and bacteria and recirculated back into the treatment cell.

In approximately 200 days of treatment, TPH was analyzed and the soils were below Ohio EPA standards of 105 mg/kg.

## SECTION 1.0 - INTRODUCTION

Bioremediation is capable of degrading organic compounds in contaminated soils. The method of applications may vary but all bioremediation applications use microorganisms indigenous to the site (bacteria and fungi) to degrade the contaminants of concern to carbon dioxide, cell mass and water. The rates of bioremediation of contaminated soils are controlled by optimizing the following: oxygen levels, moisture content, nutrient availability, pH, soil type, and the bacterial population.

A solid phase biotreatment program requires optimization of these factors to accelerate degradation rates. The following sections discuss in greater detail the results of the bioremediation program at the Dayton site.

## SECTION 2.0 -BACKGROUND

The Dayton Thermal Products (DTP) plant is part of Chrysler Components, a division of the Chrysler Corporation (Chrysler). The site is located at 1600 Webster Street in Dayton, Ohio. The facility encompasses approximately 60 acres and contains over 1.3 million square feet under roof. Current operations at the facility include the manufacture, assembly and finishing of heat exchangers and air conditioning components for motor vehicles. The facility consists of eight manufacturing buildings, a powerhouse, wastewater treatment plant and associated storage buildings.

Past operations at the site prior to Chrysler's acquisition in 1936 included the assembly of Maxwell automobiles from about 1907 through 1936, and other manufacturing processes such as furnaces, gun parts, aluminum and copper tube forming operations, light machining, plating, metal stamping, welding, soldering, degreasing, painting, plastic molding and assembly, as well as maintenance of these processes, equipment and structures. The Maxwell Complex, which was a group of twelve former buildings, was used by Chrysler until 1990 when it was demolished. A portion of the Maxwell Complex footprint was replaced by a new manufacturing building (number 59) in 1991. Investigations completed during the demolition and construction indicated that the soils were impacted with petroleum hydrocarbons and volatiles. The excavated soils were stockpiled on site to be remediated at a later date.

# SECTION 3.0 - BIOTREATABLITY STUDY

The purpose of the biotreatability study was to determine if indigenous microorganisms found at DTP were capable of degrading the petroleum hydrocarbons found in the soil. The treatability study also included extensive testing of the TPH concentration in the excavated soils.

## SOIL SAMPLING

In order to determine the extent of contamination and to collect a representative collection of samples for the treatability study, several composite soil samples were taken from the two (2) soil piles contained on site. The first set of six (6) samples were taken from the pile designated the "TPH pile". These samples were composites which were collected from borings at the top of the pile and at various locations on the side slopes of the piles. The borings had an average depth of four (4) feet.

The second set of six (6) samples were taken from the pile designated as the "unknown pile" A total of six (6) composite samples were taken from borings at the top and from various locations on the side slopes of the pile. The borings had an average depth of six (6) feet.

## TREATABILITY STUDY

The soil samples were analyzed for pH, nitrate-nitrogen, phosphorous, organic matter, ammonia-nitrogen, nitrite-nitrogen and soil moisture prior to beginning the treatability study. The following table presents the results of those analyses.

TABLE 1

SOIL CHEMICAL CHARACTERISTICS - INITIAL SAMPLES - DAYTON

| Sample No | pH | Nitrate | Phosphorous | Ammonia Nitrogen | Nitrite | Organic Content | Moisture % |
|---|---|---|---|---|---|---|---|
| TPH1 | 8.2 | <5 ppm | 100 ppm | ND | ND | ND | 19.65 |
| TPH2 | 8.1 | <5 ppm | 75 ppm | ND | ND | ND | 17.87 |
| TPH3 | 8.2 | <5 ppm | 100 ppm | ND | ND | ND | 20.2 |
| TPH4 | 8.5 | <5 ppm | 75 ppm | ND | ND | ND | 9.8 |
| TPH5 | 8.5 | <5 ppm | 100 ppm | ND | ND | ND | 2.11 |
| TPH6 | 8.1 | <5 ppm | 100 ppm | ND | ND | ND | 7.34 |
| Unknown 1 | 8.3 | <5 ppm | 75 ppm | ND | ND | ND | 7.38 |
| Unknown 2 | 8.2 | 10 ppm | 100 ppm | ND | ND | ND | 6.01 |
| Unknown 3 | 8.6 | <5 ppm | 75 ppm | ND | ND | ND | 8.24 |
| Unknown 4 | 8.3 | <5 ppm | 75 ppm | ND | ND | ND | 9.75 |
| Unknown 5 | 8.4 | <5 ppm | 100 ppm | ND | ND | ND | 8.47 |
| Unknown 6 | 8.2 | <5 ppm | 75 ppm | ND | ND | ND | 6.43 |
| TPH Average * | 8.25 | <5 ppm | 91.67 ppm | ND | ND | ND | 12.8 |
| Unknown Average* | 8.3 | <5 ppm | 83.3 ppm | ND | ND | ND | 7.7 |
| Composite * | 8.2 | <5 ppm | 75 ppm | ND | ND | ND | 11.54 |

NOTE
*Average - The arithmetic average of the samples taken from DTP
*Composite - The chemical characteristics of the samples used for the biotreatability study which was a composite from each of the twelve samples
ND = Not Detected (<1 ppm)

To initiate the study, a composite was taken from the twelve soil samples to create one composite sample for the treatability study. Fifty (50) grams of this composite sample were analyzed for initial TPH content.

Next, approximately fifty (50) grams of the composite sample were placed into each reactor vessel. The reactor vessels were allowed to stabilize and become acclimated for a period of two (2) days before their physical and chemical environments were altered. This permitted the determination of background respiration rates for each reactor vessel of what is known as the "lag phase" of bacterial growth.

Before the amendments were added, respiration rates during the lag phase were measured to ensure that the flasks which were amended were below or equal to the respiration rates measured in the two (2) control flasks. A total of five treatment variations were completed for the study. The reactor vessels were amended in the following manner:

TABLE 2

BIOMETER FLASK COMPOSITES

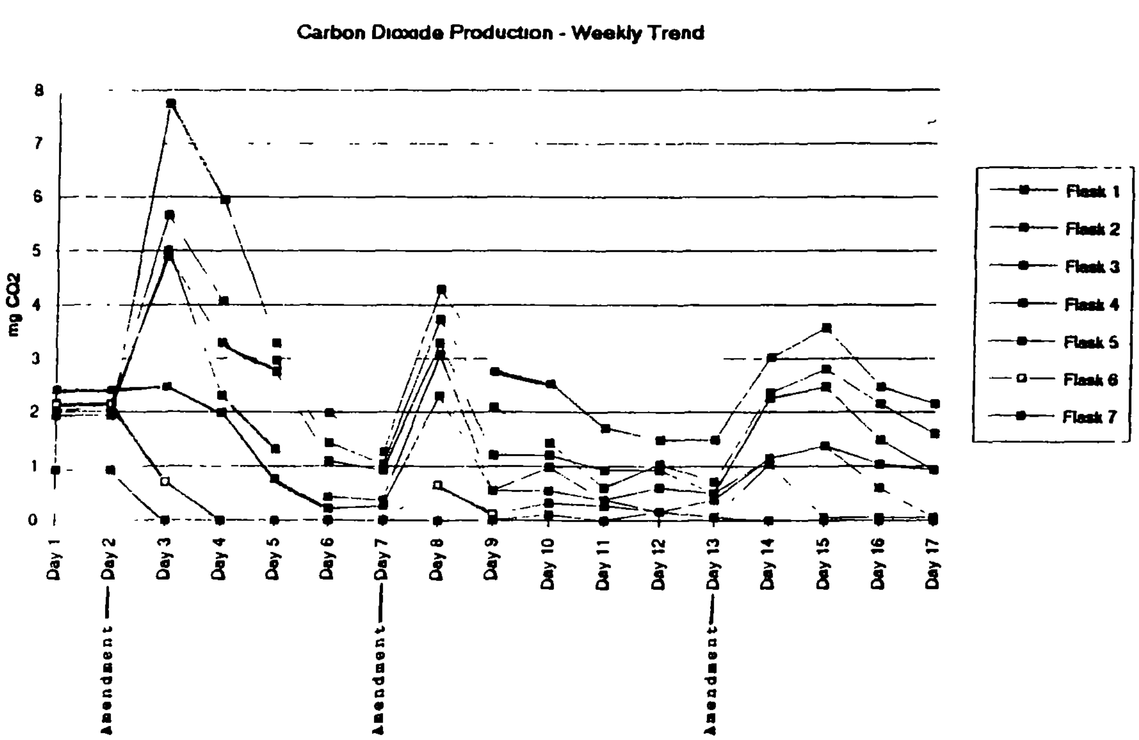
| Reactor Vessel | Nutrient Percentages (Nitrogen, Phosphorous) |
|---|---|
| 1 | 2% |
| 2 | 4% |
| 3 | 5% |
| 4 | 6% |
| 5 | 8% |
| 6 | No amendments (Live Control) |
| 7 | No amendments (Sodium Azide - Killed Control) |

(NOTE: Nutrients: N:P = 10:15 ratio)

Biometer flasks numbers 6 and 7 were tested as controls. Flask number 6 contained a portion of the composite sample that was not chemically killed. This flask served as a live control that provided background respiration rates of the bactéria throughout the study. Flask number 7 also contained a portion of the composite sample, but any microbes present in the sample were destroyed chemically with sodium azide (1% v/w final concentration). This second control provided data on the amount of carbon dioxide which could evolve from the soil and not the microbes.

The study was conducted over a ten day period (day in this study refers to a 24 hour period). All of the flasks were monitored for daily $CO_2$ production levels. As mentioned earlier, the flasks were allowed to equilibrate for two days (48 hours) before the nutrient amendments were added. Additional nutrients were added on Day four because the majority of nutrients were adsorbed to the clay of the soils, thereby making it unavailable. The second addition of an aliquot of nutrients was used to assess its affect on microbial activity.

## CO2 GRAPH FROM TREAT STUDY



## STUDY RESULTS

The purpose of the treatability study was to determine the site conditions which should be altered for optimal biodegradation. The study concluded that biological activity was occurring at minimal rates at the site due to restrictive growth factors. In order to increase the rate of biodegradation the microbial population could be increased by adjusting those environmental factors found to be restrictive which included:

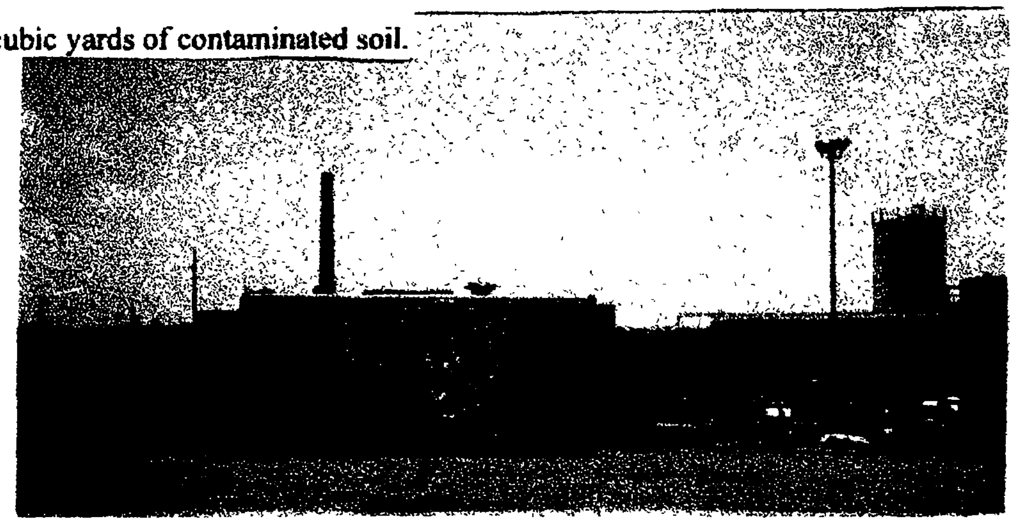
- pH - The existing soils were slightly alkaline. Therefore, the pH of the soil needed to be neutralized. However, as the bacteria reduce the contaminants of concern, the pH of the soil will be reduced or acidified.
- Organic matter - It was determined that the site soils were depleted of organic matter. The soils need to be amended with peat or other organic rich substances during bioremediation. This will increase the nutrients present in the soil and also assist with aeration.
- Nutrients - The treatability study confirmed that all essential nutrients were lacking in the site soils. The soils needed to be amended with nitrogen and phosphorous to enhance biodegradation.
- Oxygen Availability - Due to the soils being stockpiled, oxygen diffusion did not occur readily.

In summary, the treatability study indicated that biological activity was occurring at minimal levels due to restrictive growth factors at the site. Much higher nutrient amendments were required to sustain biological activity due in part to high nutrient adsorption capacity of the site soils and increased oxygen availability was necessary. Based on the observations of the treatability study, it was determined that full scale bioremediation of the impacted soils was possible as long as the restrictive growth factors were monitored periodically.

## SECTION 4.0 - BIOREMEDIATION OF TPH IMPACTED SOILS

### TREATMENT CELL CONSTRUCTION

In order to remediate the soils, it was necessary to consolidate the soils into one treatment cell. A 15 mil liner was installed over an existing area of pavement near the railroad tracks. The liner was impermeable to prevent any contaminants from leaching into the soils beneath the treatment cell. The soils were then placed on the liner system in a series of 2 lifts. The first lift was four (4) feet high. the second lift was three (3) feet high. Upon completion of the lifts, the entire biotreatment cell perimeter was surrounded by an earthen berm. The average depth of the soils placed in the treatment cell was approximately seven (7) feet. Once filled. the treatment cell contained approximately 15.000 cubic yards of contaminated soil.



### BIOREACTOR OVERVIEW

The bioreactor utilized at the site was a modified sequencing batch reactor (MSBR). The MSBR was filled on a semi-continuous basis using a fill consisting of potable water and/or recycled water from the treatment cell. The MSBR was controlled through a series of internal floats. Once the reactor was filled and operational, the system was continuously mixed and aerated by a diffuser system. As the mixing was occurring, the microbes identified and cultured in the earlier treatability study were fed into the reactor on a semi-continuous basis. The addition of selected nutrients occurred continuously with periodic adjustments, which was based on analyses. The nutrient rich, microbe laden water was then discharged through a series of PVC pipes which vertically penetrated the surface of the treatment cell. Introducing the discharge to the top of the treatment cell allowed for the total filtration of the microbes and nutrients throughout the contaminated soil. The bioreactor became operational in July 1993.

BIOLOGICAL MONITORING THROUGH THE BIOTREATMENT PROCESS

The soils in the treatment cell were periodically analyzed for the following parameters: pH, phosphorous, nitrate, nitrite, and ammonia. In addition to these parameters, soil moisture and TPH were also analyzed. The analytical methods used were as follows:

- Soil pH - EPA Method 9045;
- Soil phosphorous - EPA Method 365.3 Modified;
- Nitrate - EPA Method 350.2 Modified;
- Nitrite - EPA Method 353.2 Modified;
- Ammonia - Modified EPA Method 350.2 - Nesslers;
- Soil moisture - Standard Method 2540-G;
- TPH - EPA Method 9071.

In addition, the soils were periodically monitored for microbial population and respiration.

BIOLOGICAL CONTROL MONITORING REQUIREMENTS

The treatability study concluded that there were indigenous microbes on-site which were capable of degrading the contaminants of concern. In order to accelerate the growth of microorganisms, site conditions were altered to those determined optimal during the treatability study. The following is a discussion of the treatment cell chemical and biological characteristics.

pH

The initial pH characteristics of the soil were slightly basic. The pH at the start of remediation averaged 8.2. As the soils continued to be amended, the pH decreased to 7.25 which is more acceptable for bioremediation.

Nutrient Concentration

The treatability study concluded that the soils were depleted in such essential nutrients as nitrogen and phosphorous. Ammonia as nitrogen, nitrite and nitrate as well as phosphate were analyzed routinely throughout treatment. Phosphate averaged 75 mg/kg at the start of the treatment program. Levels increased throughout the study until the end of the treatment with a final concentration of phosphorous of more than 200 mg/kg. Nitrate concentrations were below detection limits at the start of the treatment program. Concentration continued to increase throughout the treatment program and at the end of the remediation program was 15 mg/kg.

MICROBIAL POPULATION

The soils were also analyzed to determine microbial growth using the standard plate count method, which is a direct quantitative measurement of viable aerobic and facultative anaerobic bacteria present in the soil. The method used to quantify the bacterial population in the soil was adapted from the method as outlined in EPA Microbiological Methods for Monitoring the Environment (EPA 600/8-78-017). The microbial population at the start of treatment averaged $10^7$ colony forming units per gram (cfu/g) and increased to more than $10^{15}$ cfu/g at the completion of the remediation program. At microbial concentrations of more than $10^6$ cfu/g, contaminant reduction in soil has been documented to be a function of the activity of the microbial population.[1] The growth in the population of microbes indicated that the addition of the nutrients and other factors were also degrading the contaminants of concern.

[1] Bianchini, Porter, Pugisaki - Detection of Optimal Toxicant Loads for Biological Closure of a Hazardous Waste Site, Aquatic Toxicology Annual Symposium, 1986.

## SECTION 5.0 - DISCUSSION

INORGANIC COMPOSITE SOILS

The key to accelerating the natural biodegradation process was to provide a sufficient concentration of nutrients and minerals for the indigenous bacteria. The inorganic material must be readily available to the bacteria present in the soil. Nitrogen, in all forms, as well as phosphorous were the most critical nutrients lacking in the soils at DTP. This was determined in the treatability study and confirmed during the treatment of the contaminated soils.

The initial sampling confirmed that the soils in the treatment cell were lacking the essential nutrients needed to accelerate the natural biodegradation process. As treatment progressed, the soils increased in nitrate and phosphorous. As the bioreactor system continued to feed the treatment cell, the levels of nutrients gradually increased until nutrients were no longer the limiting factor in the bioremediation of these soils.

STANDARD PLATE COUNT

To evaluate biological activity, total heterotrophic organisms in the treatment cell were enumerated. Samples were plated onto mineral media containing specific hydrocarbons which were the sole source of carbon. The soils were plated on substrate specific hydrocarbon to identify and study the specific organisms. The microbial population in the treatment cell increased over time due to a number of factors. The first factor included the continuous nutrient feed supply from the bioreactor. The second factor affecting microbial cell counts was the continuous feed of microbe laden water from the bioreactor. As the system continued to operate the microbial population was monitored to ensure that the population continued to increase. This data used in conjunction with the TPH results indicated the rate at which the microbes were remediating the soils in the treatment cell.

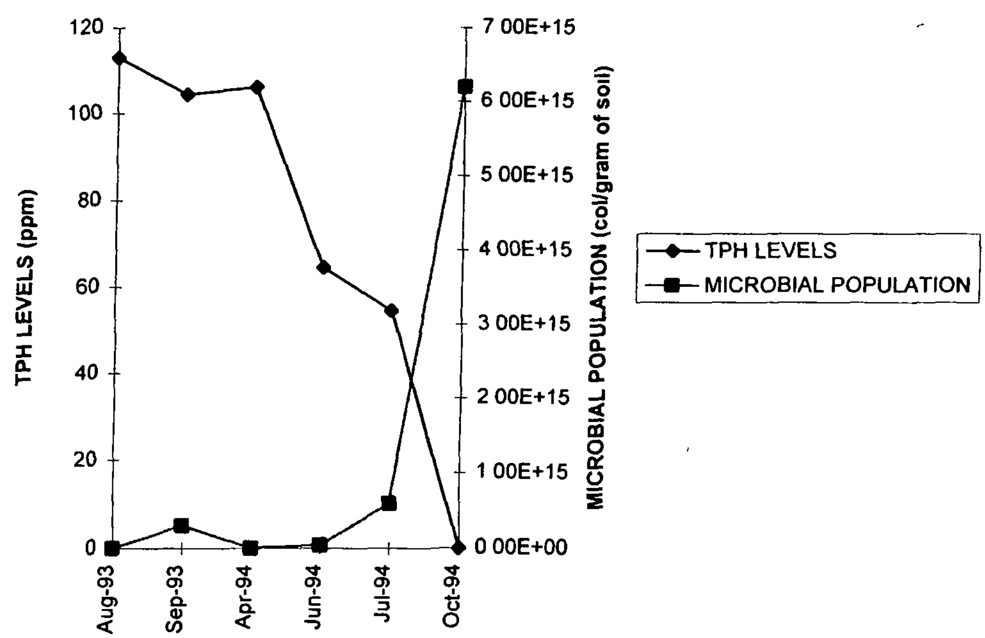
TPH Monitoring

Soils in the treatment cell were analyzed periodically for TPH concentration using Method 9081. The soil TPH concentration decreased on average from 113 ppm to <10 ppm. Over the fourteen (14) month period that the bioreactor operated, TPH values decreased overall by 99%, due to the continuous feed of nutrient enriched, microbe laden water to the bacteria present in the soil. The results indicate a high initial contaminant reduction followed by a period of reduced rate as the concentrations of TPH were reduced and as the microbial community changed.

## SECTION 6.0 - CONCLUSIONS

After approximately eight weeks of operation, microbial activity at the site began to increase. The analyses indicated the population of hydrocarbon degrading microbes increased throughout the treatment process. Environmental conditions of the soils were greatly improved over those found initially which allowed the indigenous microbes to function at optimal levels.

The graph below illustrates the correlation between decreasing TPH concentrations and increasing microbial numbers throughout the treatment process. The graph illustrates the effectiveness of the existing microbial population to degrade the contaminants of concern.



6-Sep-93

Doug Orf
Acustar
1600 Webster Street
Dayton, OH 45404

**PROJECT NUMBER: 6001**
**PROJECT : CHRYSLER - ACUSTAR**

| ANALYSIS/ METHOD | RESULTS | UNITS | DATE ANALYZED | MDL |
|---|---|---|---|---|
| **SAMPLE CODE: Biotreatment Cell Composite** | | | | |
| **DATE SAMPLE COLLECTED:8/19/93** | | | | |
| TPH/EPA 9071 | 113.0 | mg/L | 24-Aug-93 | 10.0 |

Christopher J. Candela
Environmental Scientist

*All analyses are performed in accordance with those outlined in EPA Methods for Chemical Analysis of Water and Wastes and in Standard Methods for the Examination of Water and Waste Water, 17th edition, unless otherwise noted.*

18-Oct-93

Doug Orf
Acustar
1600 Webster Street
Dayton, OH 45404

**PROJECT NUMBER: 6001**
**PROJECT : CHRYSLER - ACUSTAR**

| ANALYSIS/ METHOD | RESULTS | UNITS | DATE ANALYZED | MDL |
|---|---|---|---|---|
| **SAMPLE CODE: Biotreatment Cell Sample D-1** | | | | |
| **DATE SAMPLE COLLECTED:9/30/93** | | | | |
| TPH/EPA 9071 | 115.0 | mg/L | 12-Oct-93 | 10.0 |
| **SAMPLE CODE: Biotreatment Cell Sample D-2** | | | | |
| **DATE SAMPLE COLLECTED:9/30/93** | | | | |
| TPH/EPA 9071 | 98.0 | mg/L | 12-Oct-93 | 10.0 |
| **SAMPLE CODE: Biotreatment Cell Sample D-3** | | | | |
| **DATE SAMPLE COLLECTED:9/30/93** | | | | |
| TPH/EPA 9071 | 100.0 | mg/L | 12-Oct-93 | 10.0 |

**SAMPLE CODE: Biotreatment Cell Sample D-4**

**DATE SAMPLE COLLECTED:9/30/93**

| | | | | |
|---|---|---|---|---|
| TPH/EPA 9071 | 105.0 | mg/L | 12-Oct-93 | 10.0 |

Christopher J. Candela
Environmental Scientist

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28-Apr-94

Doug Orf
Acustar
1600 Webster Street
Dayton, OH 45404

**PROJECT NUMBER: 6001**
**PROJECT : CHRYSLER - ACUSTAR**

| ANALYSIS/ METHOD | RESULTS | UNITS | DATE ANALYZED | MDL |
|---|---|---|---|---|
| **SAMPLE CODE: Biotreatment Cell Sample D-1** | | | | |
| **DATE SAMPLE COLLECTED:4/7/94** | | | | |
| TPH/EPA 9071 | 115.0 | mg/L | 18-Apr-94 | 10.0 |
| **SAMPLE CODE: Biotreatment Cell Sample D-2** | | | | |
| **DATE SAMPLE COLLECTED:4/7/94** | | | | |
| TPH/EPA 9071 | 100.0 | mg/L | 18-Apr-94 | 10.0 |
| **SAMPLE CODE: Biotreatment Cell Sample D-3** | | | | |
| **DATE SAMPLE COLLECTED:4/7/94** | | | | |
| TPH/EPA 9071 | 105.0 | mg/L | 18-Apr-94 | 10.0 |

**SAMPLE CODE: Biotreatment Cell Sample D-4**
**DATE SAMPLE COLLECTED:4/7/94**

| | | | | |
|---|---|---|---|---|
| TPH/EPA 9071 | 105.0 | mg/L | 18-Apr-94 | 10.0 |

Christopher J. Candela
Environmental Scientist

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28-Jul-94

Doug Orf
Acustar
1600 Webster Street
Dayton, OH 45404

**PROJECT NUMBER: 6001**
**PROJECT : CHRYSLER - ACUSTAR**

| ANALYSIS/ METHOD | RESULTS | UNITS | DATE ANALYZED | MDL |
|---|---|---|---|---|
| **SAMPLE CODE: Biotreatment Cell Sample D-1** | | | | |
| **DATE SAMPLE COLLECTED:6/12/94** | | | | |
| TPH/EPA 9071 | 28.3 | mg/L | 27-Jun-94 | 10.0 |
| **SAMPLE CODE: Biotreatment Cell Sample D-2** | | | | |
| **DATE SAMPLE COLLECTED:6/12/94** | | | | |
| TPH/EPA 9071 | 113.4 | mg/L | 27-Jun-94 | 10.0 |
| **SAMPLE CODE: Biotreatment Cell Sample D-3** | | | | |
| **DATE SAMPLE COLLECTED:6/12/94** | | | | |
| TPH/EPA 9071 | 85.0 | mg/L | 27-Jun-94 | 10.0 |

**SAMPLE CODE: Biotreatment Cell Sample D-4**
**DATE SAMPLE COLLECTED:6/12/94**

| | | | | |
|---|---|---|---|---|
| TPH/EPA 9071 | 56.7 | mg/L | 27-Jun-94 | 10.0 |

Christopher J. Candela
Environmental Scientist

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3-Aug-94

Doug Orf
Acustar
1600 Webster Street
Dayton, OH 45404

**PROJECT NUMBER: 6001**
**PROJECT : CHRYSLER - ACUSTAR**

| ANALYSIS/ METHOD | RESULTS | UNITS | DATE ANALYZED | MDL |
|---|---|---|---|---|
| **SAMPLE CODE: Biotreatment Cell Sample D-1** | | | | |
| **DATE SAMPLE COLLECTED:7/19/94** | | | | |
| TPH/EPA 9071 | 20.0 | mg/L | 27-Jul-94 | 10.0 |
| **SAMPLE CODE: Biotreatment Cell Sample D-2** | | | | |
| **DATE SAMPLE COLLECTED:7/19/94** | | | | |
| TPH/EPA 9071 | 95.6 | mg/L | 27-Jul-94 | 10.0 |
| **SAMPLE CODE: Biotreatment Cell Sample D-3** | | | | |
| **DATE SAMPLE COLLECTED:7/19/94** | | | | |
| TPH/EPA 9071 | 70.0 | mg/L | 27-Jul-94 | 10.0 |

**SAMPLE CODE: Biotreatment Cell Sample D-4**
**DATE SAMPLE COLLECTED:7/19/94**

| | | | | |
|---|---|---|---|---|
| TPH/EPA 9071 | 32.8 | mg/L | 27-Jul-94 | 10.0 |

Christopher J. Candela
Environmental Scientist

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3-Nov-94

Doug Orf
Acustar
1600 Webster Street
Dayton, OH 45404

**PROJECT NUMBER: 6001**
**PROJECT : CHRYSLER - ACUSTAR**

| ANALYSIS/ METHOD | RESULTS | UNITS | DATE ANALYZED | MDL |
|---|---|---|---|---|
| **SAMPLE CODE: Biotreatment Cell Sample D-1**<br>**DATE SAMPLE COLLECTED:10/21/94** | | | | |
| TPH/EPA 9071 | ND | mg/L | 25-Oct-94 | 10.0 |
| **SAMPLE CODE: Biotreatment Cell Sample D-2**<br>**DATE SAMPLE COLLECTED:10/21/94** | | | | |
| TPH/EPA 9071 | ND | mg/L | 25-Oct-94 | 10.0 |
| **SAMPLE CODE: Biotreatment Cell Sample D-3**<br>**DATE SAMPLE COLLECTED:10/21/94** | | | | |
| TPH/EPA 9071 | ND | mg/L | 25-Oct-94 | 10.0 |

**SAMPLE CODE: Biotreatment Cell Sample D-4**
**DATE SAMPLE COLLECTED:10/21/94**

| | | | | |
|---|---|---|---|---|
| TPH/EPA 9071 | ND | mg/L | 25-Oct-94 | 10.0 |

*** Sample splits sent to third party laboratory for analysis verification. ***

Christopher J. Candela
Environmental Scientist

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FEB-27-95 MON 5:48 PM MEDLAB ENVIRONMENTAL FAX NO. 3024277281 P. 2

From: Medlab Environmental Testing, Inc.
212 Cherry Lane
New Castle, DE 19720

February 27, 1995

To: Clean Technologies
2700 Capitol Trail
Newark, DE 19711

The following analytical results have been obtained for the indicated sample which was submitted to this laboratory:

| | |
|---|---|
| Sample I.D. AA68858 | Client Code: CLEAN-01 |
| Purchase order number: 350 | SAMPLE LOCATION: [redacted] |
| SAMPLE ID: [redacted] | |
| Sample collection date [redacted] | Time: 08:30 |
| Lab submittal date [redacted] | Time: 15:10 |
| Job Names: Chrysler Twinsburg | Telephone Number: 999-0924 |
| FAX Number: 999-0928 | |

| Parameter | Result | Units | MDL |
|---|---|---|---|
| BTEX by GC/PID | see below | ug/kg | |
| Diesel Range Organics | <10 | mg/kg | 10 |

Data for BTEX by GC/PID ug/kg:

| Component Name | Result | Component MDL |
|---|---|---|
| Benzene | 5 U | 5 |
| Toluene | 5 U | 5 |
| Ethyl Benzene | 5 U | 5 |
| m&p-Xylene | 10 U | 10 |
| o-Xylene | 5 U | 5 |

If there are any questions regarding this data, please call.

John R Harper for

Michael Shmookler, Ph.D.
Laboratory Director

CLEANTECH

Clean Tech, Inc
Environmental Consultants
2700 Capitol Trail
Newark, DE 19711
302•999•0924
FAX 302•999•0925

RECEIVED
ENVIR
JAN 25 1995

January 17, 1995

Mr Curtis Chapman
Chrysler Corporation
2301 Featherstone Road
CIMS 429-02-04
Auburn Hills, MI 48326-2808

**RE: Site Investigation Status**
**Chrysler Dayton Thermal Products**
**Dayton, Ohio**

Dear Mr. Chapman:

Site investigation activities during the installation of soil borings and groundwater monitoring wells have generated both soil and groundwater as waste materials A total of 10 soil borings and 15 monitoring wells were installed as per the Work Plan. These activities generated a total of 143 drums of soil cuttings These drums are marked and staged on site. The well development activities produced several hundred gallons of groundwater which were delivered to the on site wastewater treatment plant for disposal.

The first of the two planned groundwater sampling events took place 12/13 through 12/15/94 with representatives of Clean Tech and Geotrans present on site. At that time all 15 wells were sampled for laboratory analysis. The wells were purged prior to sampling and the purged water was placed in drums and retained near each well.

As per our discussion this date, Clean Tech will proceed to deliver the purged groundwater collected during the first groundwater sampling round to Chrysler's on site wastewater treatment plant. The soil cuttings produced during the well installations will be placed on site at some suitable location near the Clean Tech soil bioremediation project currently underway

The geophysical logging of the on site production water well will not be performed. The purpose of logging the well was to determine the depth to the clay layer separating the water table aquifer and the underlying semi-confined aquifer This has now become unnecessary since the well installations have provided this information

()

Representatives of Clean Tech plan to be on site January 24, 1995 to collect a second round of water level measurements, and to collect the second round of groundwater samples beginning February 20, 1995.

Clean Tech has prepared the following schedule for submission of our draft report for the site investigation at the referenced facility. The report will be presented in sections as noted for your review and comments. A copy of our report outline is attached. The planned submittal dates and report sections to be submitted are:

January 27, 1995
Introduction, Soil Vapor Survey, Groundwater Analytical Results (Round #1)

February 17, 1995
Groundwater Monitoring Wells, Soil Borings, Soil Sampling and Analysis, Groundwater Sampling and Analysis, Soil Analytical Results, Geology

March 31, 1995
Water Level Measurements (includes Surveying Methods), Groundwater Analytical Results (Round #1 & #2), Hydrogeology, Contaminant Distribution, Interpretations of Contaminant Distribution, Wastes Disposal Methods, Recommendations

If you have any questions, please contact me at (302) 999-0924

Sincerely,

Steven W. Newsom

Steven W. Newsom, P G.
Principal Geologist
CLEAN TECH

e:\usr-data\steve\chrysler\schedrpt doc

Site Investigation Report of Findings
Chrysler Corporation
Dayton Thermal Products Division
Proposed Outline

Section 1.0 - Introduction
Section 2.0 - Soil Vapor Survey
Section 3.0 - Soil Borings
Section 4 0 - Soil Sampling and Analysis
Section 5 0 - Groundwater Monitoring Wells
Section 6.0 - Groundwater Sampling and Analysis
Section 7.0 - Water Level Measurements
Section 7.1 - Method of Collection
Section 7 2 - Findings
Section 8 0 - Laboratory Results for Soil Samples
Section 9 0 - Laboratory Results for Groundwater Samples
Section 9 1 - Groundwater Sampling Round #1
Section 9 2 - Groundwater Sampling Round #2
Section 10 0 - Geology
Section 10 1 - Regional Geology
Section 10.2 - Site Geology
Section 11 0 - Hydrogeology
Section 11.1 - Regional Hydrogeology
Section 11.2 - Site Hydrogeology
Section 11 2.1 - Unconfined Aquifer
Section 11.2.2 - Upper Semi-Confined Aquifer
Section 11.2.3 - Vertical Flow Potential
Section 12 0 - Contaminant Distribution
Section 12.1- Soil Vapor Survey Contaminant Distribution
Section 12 1.1 - Shallow Soil Vapor Samples
Section 12.1.2 - Deep Soil Vapor Samples
Section 12.2 - Soil Contaminant Distribution
Section 12 3 - Groundwater Contaminant Distribution
Section 12.3 1 - Groundwater Sampling Round #1
Section 12.3 2 - Groundwater Sampling Round #2
Section 12.3 3 - Discussion of Groundwater Contaminant Distribution
Section 13.0 - Interpretations of Contaminant Distribution Patterns
Section 14.0 - Waste Disposal Methods
Section 15 0 - Recommendations
Section 15.1 - Summary of Findings
Section 15.3 - Remedial Options

# MEMORANDUM

**DATE:** OCTOBER 4, 1994

**TO:** Curt Chapman

**FROM:** Deborah A. Buniski

**RE:** Site Investigation Activities at Dayton

**CC:** A. Aquwa

Curt:

As we discussed we will be arriving at the Dayton plant on Sunday-October 9, 1994. We will have employees from Clean Tech at the site on that day. The Geoprobe system will also mobilize on October 9, 1994 from Pittsburg, PA. The GC/mobile lab will be set up on October 9, 1994. The first full day of field activity will be October 10, 1994. The week of October 10-16 will consist of soil gas analysis. We have discussed the work plan and the need to locate utilities with Doug Orf. He has located all storm, gas, sanitary and fire supply lines on a map. He is attempting to also locate the electrical lines on a drawing. We have discussed our drilling and soil gas locations with Doug who is in agreement on the chosen locations. On October 17 we will mobilize two drill rigs to begin the soil boring program and the installation of the deep wells. At that time Geotrans will mobilze to the site. Geotrans will provide a geologist to oversee one drill rig and CT will provide another to supervise the second rig. During the soil gas and part of the soil boring program I will be on-site supervising activities. Once the drilling program is underway, our geologist-Steve Newsom-who is a professional geologist will supervise the activities. Once we have mobilized to the site we will contact you to keep you aware of our activities.